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FEASIBILITY STUDY OF REMEDIAL ALTERNATIVES

BRIDGEPORT RENTAL AND OIL SERVICES SITE  
LOGAN TOWNSHIP, NEW JERSEY

EPA WORK ASSIGNMENT  
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## EXECUTIVE SUMMARY

### Introduction

A Remedial Investigation was performed by NUS Corporation (NUS) in the summer and fall of 1983 at the Bridgeport Rental and Oil Services (BROS) Site. The purpose of this investigation was to characterize the types and extent of contamination at the site with the objective of using the information for the preparation of this Feasibility Study of Remedial Alternatives for the remediation of the BROS Site. The work performed during the Remedial Investigation included geophysical investigations (electromagnetic conductivity, vertical electrical sounding, and magnetometry), subsurface investigations (17 monitoring wells and two test borings), and environmental and waste sampling, including groundwater, surface water, sediment, tank waste, and lagoon waste (oil, aqueous, and sediment/sludge). Most of the analytical results from these samplings have been validated and received, with the exception of the inorganic analyses for the first round of groundwater samples and the inorganic analyses for lagoon water and offsite surface water/sediment samples.

The Feasibility Study for the BROS Site has been prepared at the request of the United States Environmental Protection Agency (EPA) Region II under Work Assignment Number 08-2M07.0. This study was prepared in accordance with the requirements of the National Oil and Hazardous Substances Contingency Plan (NCP) published pursuant to Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

### The Site

The BROS Site is located in southwestern New Jersey, approximately one mile east of the Town of Bridgeport and about two miles south of the Delaware River. The total area of the site is approximately 30 acres, and the pertinent features of the site include a tank farm (containing about 90 tanks and process vessels) and a 12.7-acre waste oil and wastewater lagoon that was reportedly formed by sand and

gravel mining operations. The lagoon contains a substantial quantity of water, a waste-oil layer floating on the surface of the water, and an oily sediment/sludge.

### Remedial Investigation Results

The results of the Remedial Investigation at the BROS Site indicate that substantial contamination exists on and around the site. The primary contaminant source appears to be the 12.7-acre lagoon. The oil layer floating on the surface of the lagoon (estimated to be 2 to 3 million gallons) has been shown to contain Polychlorinated Biphenyls (PCBs) at an average concentration that exceeds 500 parts per million (ppm). Other contaminants detected in the oil include ethylbenzene (11.5 to 50.9 ppm) and toluene (35 to 74 ppm). The sediment phase at the bottom of the lagoon has also been shown to contain PCBs, although the distribution of PCBs in the sediment is uncertain, as demonstrated by the wide range of detected concentrations (7.5 to 2,010 ppm); nevertheless, the average of all sediment samples did exceed 500 ppm PCB. The aqueous phase of the lagoon did not show the presence of PCBs, although a variety of Hazardous Substances List (HSL) organics was detected in the parts per billion range (ppb).

The characteristics of the BROS lagoon are such that it has contaminated local groundwater, surface water, and sediment, and will continue to contaminate these environmental media unless some action is taken. The base of the lagoon extends from 5 to 10 feet into the underlying aquifer and the surface of the lagoon has been as much as 10 feet above the level of the water table. (Actions ongoing at the site, as of July 1984, have lowered the lagoon level to about 5 feet above the level of the water table.) The fact that the lagoon level is above the water table results in a hydrostatic driving force that is "pushing" contaminants into the groundwater; fortunately, the oily sediment/sludge at the bottom of the lagoon acts as a semi-impermeable barrier, slowing the movement of contaminants from the lagoon into the groundwater. Nevertheless, groundwater mounding around the lagoon has been observed, indicating that the lagoon is recharging the aquifer to some degree. On the other hand, since the sediment/sludge is retarding lagoon liquid movement into the groundwater and the floating oil on the surface of the lagoon substantially

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reduces evaporation, the lagoon level rises with each rainfall. This circumstance has resulted in lagoon overflows and lagoon dike breaches, which have caused some lagoon oil and lagoon water to contaminate surface water and sediments east and northeast of the lagoon. Currently, EMPAK, Inc., of Pennsauken, New Jersey, is under contract with the U. S. Army Corps of Engineers to remove and treat the lagoon water to reduce the lagoon level. This work, which is expected to be completed this summer, will reduce the water level sufficient to provide 10 feet of freeboard; however, unless some other action is taken the lagoon level will rise once again.

Groundwater contamination resulting from the BROS Site has contaminated several domestic wells west and northwest of the site and several other residential wells in this area are being threatened by contamination. Nevertheless, because of the very flat gradient of the surficial aquifer, contaminants appear to have migrated less than 1,000 feet from the site.

Air contamination at the site was investigated with an organic vapor analyzer. No volatile organics were detected above background.

### Objectives and Approach

The goal of this Feasibility Study for the BROS Site is to identify and evaluate remedial alternatives and to recommend the most cost-effective action for minimizing the impact of the contamination on the environment and public health.

The objectives used in developing the remedial alternatives and evaluating their effectiveness include the following:

- To minimize public health and safety impacts
- To protect the quality of local groundwater and surface water

- To ensure technical feasibility, social acceptability, and cost-effectiveness of the remedial actions

The first step in selecting remedial alternatives was to identify preliminary remedial technologies for the site. These technologies were subjected to an initial screening phase in which all technologies that are not applicable, are environmentally unacceptable, or do not meet the objectives for the remediation of the site are eliminated from further consideration. The technologies that pass the initial screening are then further developed and undergo a more detailed evaluation. A major screening criterion for the BROS Site was whether a given action, when completed, would allow the lagoon waste to remain in contact with the groundwater. Any lagoon actions that would allow the majority of the lagoon waste to remain in place and continue to contaminate groundwater were not considered appropriate and were eliminated from further consideration.

The initial screening of remedial action technologies for the BROS Site, as well as the subsequent development and evaluation of alternatives, was conducted in a manner that is consistent with the guidance provided in the NCP.

#### Evaluation of Alternatives

Those alternatives that passed the initial screening process were grouped into categories, depending upon the phase of the site remediation to which they pertained (e.g., lagoon waste removal, waste disposal, tank farm, residential wells). The alternatives in each category were evaluated in terms of cost-effectiveness, and the most cost-effective action in each category was selected. The selected remedial actions from each category were then combined to form the overall recommended remedial action for the BROS Site.

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This overall recommended remedial action includes the following activities:

- Installation of a potable-water pipeline from the Pennsgrove Water Supply Company to the affected residents
- Complete removal of the tank wastes and tanks
- Removal and onsite incineration of the lagoon oil
- Removal and onsite incineration of the lagoon sediment
- Removal and onsite treatment of the lagoon water
- Lagoon closure by leaving as a pond and revegetating the sides
- Long-term monitoring of local groundwater and surface water

Incineration of the lagoon waste can be performed either on site or at an offsite location. Final design criteria, including any necessary environmental assessments, and implementation costs will be considered in selecting the most appropriate incineration location. The cost estimates contained in this report, however, suggest that onsite incineration at the BROS Site is the most economical method for disposal of both the lagoon oil and sediment.

Included as part of the tank removal is an inspection of the lagoon dike. Since the lagoon cleanout activities may not be performed for one to two years after the tank farm work is initiated, stabilization of the lagoon dike may be appropriate to ensure that the dike does not fail in the interim.

Included as part of the lagoon cleanup activities, in addition to removal and disposal of the lagoon waste, are the following: (1) surficial cleanup of about 3 acres of land east of the lagoon where visible soil contamination has been observed, (2) exploration for buried drums with appropriate disposal of any drums

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that are found, and (3) removal and disposal of debris and large objects that are contained within the lagoon or are present around the site.

The construction cost estimate and the operation and maintenance cost estimate (30-year present worth) for the recommended overall remedial action are \$55,700,000 and \$504,000 respectively.

## 1.0 INTRODUCTION

This Feasibility Study of Alternatives for the Bridgeport Rental and Oil Services (BROS) Site, Logan Township, New Jersey, has been prepared at the request of the United States Environmental Protection Agency (EPA) Region II under Work Assignment Number 08-2M07.0. This study was prepared in accordance with the requirements of the National Oil and Hazardous Substances Contingency Plan (NCP) published pursuant to Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

Section 2 of this report provides background on the BROS Site, including site location and history.

Section 3 of this report presents a summary of the findings of the Remedial Investigation conducted at the site by NUS. This investigation was specifically designed to obtain the information needed to prepare this Feasibility Study. A separate Remedial Investigation Report which details the activities and findings of the Remedial Investigation was prepared by NUS and was submitted to the EPA as a separate document.

Section 4 of this Feasibility Study Report provides a preliminary identification of potential actions that may be applicable to the remediation of the BROS Site. Also included in Section 4 is an initial screening of these potential actions. This initial screening was performed to eliminate those technologies that are clearly not applicable to the BROS Site and to identify those actions that are worthy of further detailed development and evaluation.

Section 5 presents the detailed evaluation of remedial action alternatives for the BROS Site. The alternatives that passed the initial screening phase were grouped into categories depending upon which phase of the site remediation they addressed. The alternatives in each category were evaluated within the category and a recommended alternative from each category was selected. These recommended alternatives for each category were then combined to form the overall

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recommended BROS Site remedial action. Preliminary cost estimates for the alternatives are also given in Section 5. Detailed cost estimate sheets are provided in Appendix C.

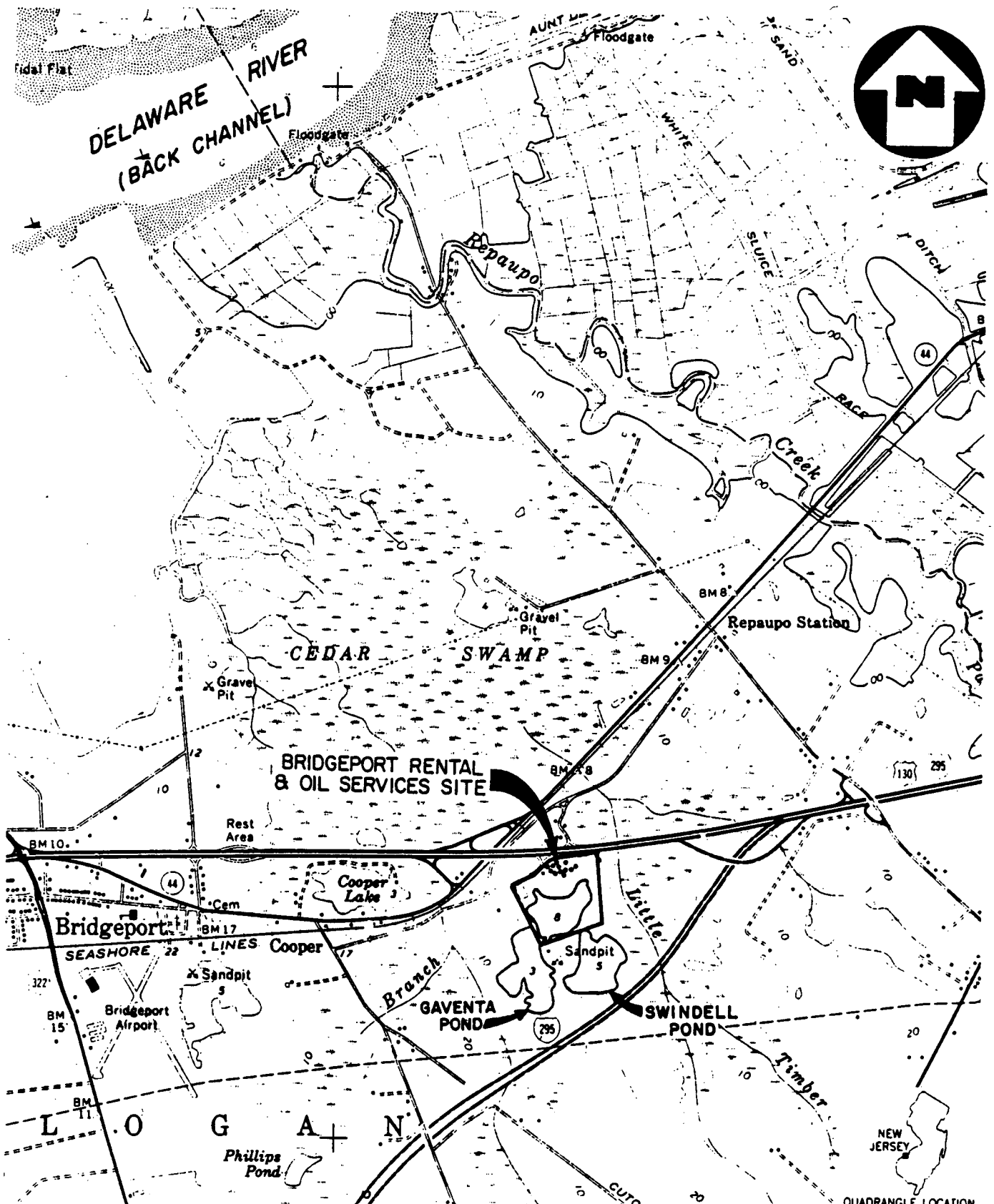
## 2.0 SITE BACKGROUND

### 2.1 Site Location

The Bridgeport Rental and Oil Services (BROS) Site is located in southwest New Jersey, approximately one mile east of the town of Bridgeport and about 2 miles south of the Delaware River, along the south side of Route 130. The general location of the site is shown in Figure 2-1. More specifically, the BROS Site is located on a parcel of land delineated as Block 59, Lots 18, 22A, 22B, and 22F on Tax Map 14A, Township of Logan, Gloucester County, New Jersey. The total area of the site is approximately 30 acres. The site consists of a tank farm containing about 90 tanks and process vessels, drums, tank trucks, and a 12.7-acre waste oil and wastewater lagoon. The lagoon was reportedly formed by previous sand and gravel dredging operations. The general arrangement of the site is shown in Figure 2-2. Drawing 0707.22-01 (provided in a pocket at the back of this report) shows the site layout and surrounding area in more detail, including the positions of local surface water bodies and the Chemical Leaman Tank Lines Site.

South and southwest of the site, adjacent to the waste oil lagoon, are three large ponds. Two of the ponds (south-southwest of the lagoon) are connected by a narrow opening and are referred to as the Gaventa Pond. The third pond is located south-southeast of the lagoon and is referred to as the Swindell Pond. The lagoon and ponds are man-made. They were excavated by a sand and gravel mining operation which started in the late 1940's and was completed by the early 1970's.

The area surrounding the BROS facility is predominantly rural and agricultural in nature, although there has been industrial development in the county. An active peach orchard (the Gaventa Orchard) borders the western edge of the BROS Site, and a private home situated within the orchard is located about 400 feet west of the lagoon. A truck repair garage is located approximately 300 feet northwest of the waste oil lagoon, and a group of four private homes is located between 800 and 1200 feet northwest of the lagoon. Three other private residences are located



BASE MAP IS A PORTION OF THE U.S.G.S. BRIDGEPORT, NJ-PA QUADRANGLE (7.5 MINUTE SERIES, 1967). CONTOUR INTERVAL 10'.

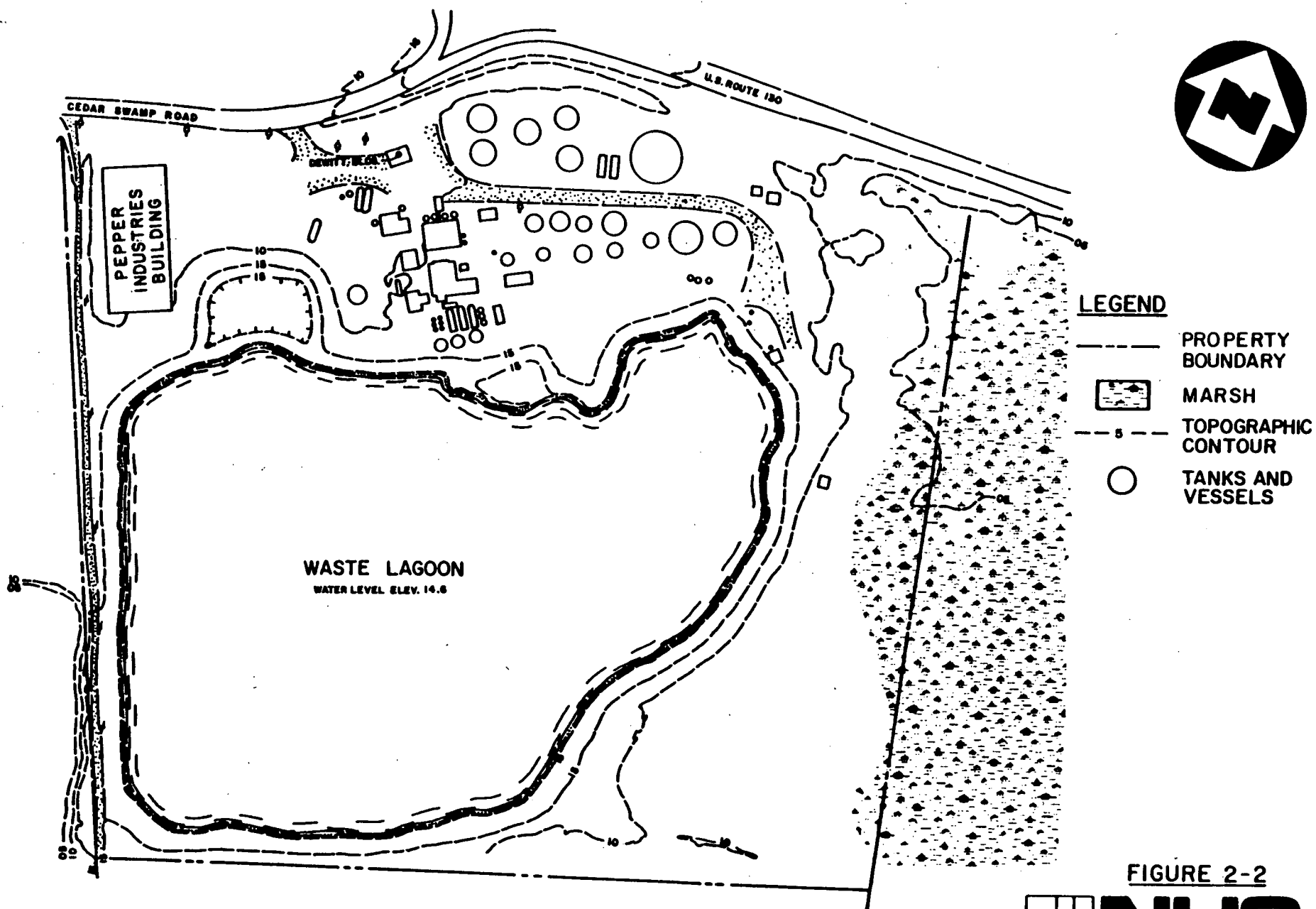
FIGURE 2-1

**LOCATION MAP**  
**BRIDGEPORT RENTAL & OIL SERVICES, LOGAN TWP., NJ**  
 SCALE: 1" = 2000'

**NUS**  
 CORPORATION

**H** A Halliburton Company

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**GENERAL SITE ARRANGEMENT**  
**BRIDGEPORT RENTAL & OIL SERVICES, LOGAN TWP., NJ**  
SCALE: 1"=200'

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north of the site, within 800 feet of the site boundary; however, these three homes are separated from the site by Route 130. East of the BROS facility is a swampy area (the Little Timber Creek Swamp) leading into Little Timber Creek. Several acres of the area immediately between the waste oil lagoon and the swamp contain dead or severely stressed vegetation.

Approximately 0.5 miles west of the BROS Site is the Chemical Leaman Tank Lines (CLTL) Site. Washing of tank trucks is carried out at the CLTL Site. In the past, wash water was directed to settling and seepage ponds, but this practice has reportedly been stopped.

Topography surrounding the BROS Site is nearly flat, typical of that found in the Atlantic Coastal Plain physiographic province. The Bridgeport area is bounded on the north by the Delaware River, and the local land is characterized by swamps and streams flowing north-northwest to the river.

The Bridgeport area is situated in a temperate climate influenced by maritime air masses. Winters are mild, and summers are long and hot. Precipitation occurs during all seasons; however, more precipitation generally occurs during the winter and spring months than during the summer and fall. The mean annual precipitation is 41.2 inches, with 20.3 inches occurring as snowfall. Evaporation typically removes about 28 inches of the precipitation, and runoff generally accounts for the removal of about 2 more inches, leaving about 11 inches of precipitation available for groundwater recharge. The average annual temperature is about 55°F. Prevailing winds are from the west-southwest.

It should be noted that the evaporation information presented above does not apply to the BROS Lagoon because the oily layer that is floating on the lagoon reduces evaporation. This situation is explained in more detail in Section 3.2.1.2, Lagoon Characterization.

## 2.2 Site History

Formation of the BROS lagoon reportedly began in the late 1930's as a result of sand and gravel dredging operations. Aerial photographs reveal that dumping in the lagoon was occurring as far back as 1940. In 1940 the area of the lagoon was about one-half acre; currently the lagoon covers 12.7 acres as determined by planimetry, using the site topographic map that was prepared in September 1983. Storage tanks were constructed at the site during the late 1950's and 1960's.

When the present owners took over the site in the late 1960's, it was used for waste oil storage and recovery and for storage tank leasing operations. The eastern dike of the lagoon was breached in the early 1970's, causing a significant area of vegetative damage. In the spring of 1981 the lagoon level began to rise, and the lagoon threatened to overflow its dikes. In response to this threat, the United States Coast Guard, using funds provided by Section 311(k) of the Clean Water Act, increased the height of the lagoon dikes. Nevertheless, in the Spring of 1982 and again in the Spring of 1983, the lagoon level rose and threatened to overflow the new dikes. On these two occasions the EPA took emergency action to lower the lagoon level by pumping out the aqueous phase of the lagoon and treating this phase using an activated carbon system. The lagoon level was lowered approximately 2 feet on each of these occasions.

Wastes remain in the lagoon and in the storage tanks at the BROS Site, although commercial waste handling activities are prohibited at the site by court order.

## 2.3 Site Investigation Objectives

Based on an initial site reconnaissance and a review of the previous site investigations performed by other contractors, NUS prepared and conducted a Remedial Investigation at the BROS Site. This investigation was designed to describe the site conditions and to provide sufficient information to develop

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remedial alternatives as described in the NCP. Areas of the site that were investigated include the waste oil lagoon, the tank farm, and the subsurface soils. Environmental media that were investigated include groundwater, surface water, sediment, and air. The information generated by this investigation was used to prepare this Feasibility Study of Remedial Alternatives. The purpose of this Feasibility Study is to recommend the cost-effective alternative for the remediation of the BROS Site. Section 3.0 of this report provides a summary of the Remedial Investigation results and findings that were used to develop this Feasibility Study.

### **3.0 SUMMARY OF THE NUS REMEDIAL INVESTIGATION ACTIVITIES AND FINDINGS**

This section presents a discussion of the Remedial Investigation activities conducted by NUS Corporation (NUS) at the BROS Site, along with a summary of the findings from these activities. For the most part, the findings presented in this Feasibility Study are based on data generated by the NUS Remedial Investigation. The primary exception is the inclusion of results from residential well sampling and analysis performed by the EPA. The results of the residential well samplings were made available to NUS by the EPA and are used in this report with the assurance from the EPA that the data are valid.

For a more detailed presentation of the Remedial Investigation activities and findings, as well as the results from previous site investigations, refer to the Remedial Investigation Report that was prepared and submitted by NUS as a separate document (NUS Project Number 0707.20).

#### **3.1 Summary of Investigation Activities**

##### **3.1.1 Subsurface Investigation**

In order to characterize the subsurface conditions beneath the BROS Site, NUS installed 17 groundwater monitoring wells and drilled 2 test borings in August and September of 1983. The locations of these monitoring wells are shown in Drawing 0707.22-01. Formation samples were collected for the initial 20-foot section of most monitoring wells using a centerline split-barrel sampler. Drill cutting samples were collected at 5-foot intervals from the sand and from the gravel and clay layers from depths of about 20 feet to the bottom of the hole. Borehole geophysical logging was performed by United States Geological Survey (USGS) geologists on the two test borings and on three monitoring well borings.

Information obtained during drilling indicates that a thick clay layer exists beneath the BROS Site. The top of this clay layer is located at a depth of about 100 feet below the ground surface in the northwest corner of the site (Well S-12) and dips

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southeast to a depth of about 140 feet below the ground surface in the southeast corner of the site (Well S-6). This clay layer is considered to be continuous at the BROS Site, but it may not be continuous over an extensive area.

Directly above the thick clay layer is located the unconfined Cape May/Magothy-Raritan Formation, which is the water table (unconfined) aquifer beneath the site. This formation consists of unconsolidated sands, gravels, and clay lenses and has a saturated thickness ranging from about 100 to 140 feet. Regional flow of this surficial aquifer is estimated to be north toward the Delaware River; however, local flow is radial around the BROS lagoon due to mounding effects from the hydrostatic head of the lagoon.

Water level measurements conducted for the water table aquifer beneath the site indicate that the water table is relatively shallow in this area. This observation is substantiated by the existence of swamps to the east and west of the site. The water levels in the Gaventa and Swindell Ponds (adjacent to the south side of the site) appear to follow the water table elevation, which is at an elevation of about 3 feet above mean sea level (MSL). Ground level at the BROS Site generally ranges from elevations of about 5 to 10 feet MSL. The water table fluctuates seasonally, as is evidenced by observed water table elevations rising an average of about 2.2 feet from September through December 1983.

The surficial, Cape May/Magothy-Raritan Formation is used as a potable water supply in the Bridgeport area. Domestic water wells are located north, northwest, and west of the site, with ten wells located within 1000 feet of the site.

A municipal water supply well, which is screened into the Magothy-Raritan Formation and which is operated by the Pennsgrove Water Supply Company, is located about 1 mile west of the site. The municipal well services an estimated population in excess of 800 persons (Camp Dresser and McKee, Inc.).

A confined aquifer probably exists below the thick clay layer beneath the site; however, self-potential and resistivity logs (performed by USGS) from one of the

test borings indicated that the water in this lower aquifer may be saline. No users of the lower aquifer were identified in the BROS Site vicinity.

### 3.1.2 Geophysical Investigations

Geophysical surveys were conducted at the BROS Site by NUS to aid in determining subsurface conditions. The surveys performed were magnetometry, electromagnetic profiling, and vertical electrical sounding.

The magnetometer survey was conducted along the east and west sides of the lagoon, and northwest of the lagoon in the vicinity of the Pepper Industries building. This survey was performed in order to define areas that may be underlain by ferromagnetic materials. Two anomalous areas, indicating possible buried ferromagnetic material, were observed along the western side of the lagoon. One of these anomalies appears to be caused by a visible pipe which connects the BROS lagoon and the Gaventa Pond. (The lack of any observable flow in this pipe indicates that the pipe is partially or completely blocked or sealed.) The source of the other anomalous area is unknown. Four anomalies were observed in the vicinity of the Pepper Industries building (northwest of the lagoon); and at least five major anomalies were observed in the area adjacent to the east side of the lagoon. The general location of these anomalous areas is illustrated in Drawing 0707.22-01. The sources of these anomalies, as well as the depths of these sources, could not be determined by the magnetometer survey. Test pits should be dug during site cleanup activities to confirm the presence of buried ferromagnetic material and to assess whether the material should be removed from the site.

Electromagnetic profiling was performed in an attempt to locate plumes of contaminated groundwater. While it is recognized that electromagnetic profiling is basically incapable of tracking organic contaminants, the tracking of conductive contaminants (e.g., chloride) by electrical methods can be used to indicate the direction of movement and relative extent of organic groundwater contamination by taking into account retardation factors. Based on the electromagnetic profiling data, it appears as though there are three plumes of groundwater contamination

spreading away from the site. These plumes appear to be spreading to the east-northeast from the lagoon, to the west-northwest from the lagoon, and to the south from the lagoon. The profiling data also indicate that the plumes have migrated less than 500 feet from the lagoon, despite the hydrostatic head of the lagoon and the mounding effects around the lagoon. This relatively small amount of contaminant migration is believed to be attributable to the flat hydraulic gradient of the water table and, to some extent, the semi-impermeable nature of the sludge at the bottom of the lagoon.

Vertical electrical soundings were performed at the BROS Site in order to provide information about background resistivity values for the area. These vertical electrical sounding data were used to correlate with the electromagnetic profiling data.

### **3.1.3 Environmental and Waste Sampling**

Environmental and waste sampling was performed at the BROS Site in order to determine the extent of contamination of environmental pathways and to evaluate the hazardous nature of wastes currently stored on the site. Samples were collected from the following media: groundwater, surface water/sediment, air, tank and drum wastes, and lagoon wastes (oil, aqueous, and sediment phases). The available results from the analyses of these samples are summarized in Section 3.2.

Groundwater sampling of the EPA and NUS monitoring wells was performed in November 1983 and January 1984. All of the analytical data for the January sampling round and the organics portion of the data from the November sampling round have been validated and were available for use in this Feasibility Study. The inorganics portion of the data from the November sampling round have not been validated as of this writing (July 1984).

Sampling of domestic water wells in the vicinity of the site was performed by the EPA. The analytical results from this sampling, for the period from March 1983 to

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April 1984, were available for the preparation of this report. These data are used in this Feasibility Study for the evaluation of residential drinking water alternatives.

Surface water and sediment sampling was performed by NUS during the Remedial Investigation. Samples were collected from the Gaventa and Swindell Ponds, and from the Little Timber Creek and Little Timber Creek Swamp east of the site. The organics portion of the analytical results from these samples are available and have been validated. Unfortunately, the inorganics analyses of these samples are not available for inclusion in this draft of the Feasibility Study.

Samples of the BROS lagoon (oil, aqueous, and sediment phases) were collected by NUS in August 1983. Four line-traverses across the lagoon were made, with samples of each lagoon phase being taken at three points along each traverse line. The three samples of each phase (collected from each traverse) were composited to yield one composite sample per lagoon phase for each line-traverse (resulting in four composite samples of each phase plus one duplicate for each phase, for a total of five samples of each lagoon phase). The analytical results from the lagoon sampling are available and have been validated, with the exception of the inorganic analyses of the lagoon water.

In addition to the lagoon sampling performed as part of the Remedial Investigation, samples of the lagoon oil and sediment were collected in January 1984. These lagoon samples were used for the testing that was performed as part of the Treatability Study for the BROS Site. A discussion of the Treatability Study and its findings is presented in Appendix A of this report.

Tank samples were also collected from the tank farm at the BROS Site. These tank samples included bulk waste samples from full or partially full tanks and drums and wipe samples from empty tanks. The analytical results for these samples have been validated and are available for evaluation in this report.

As previously mentioned, a small portion of the data from the analysis of samples collected during the Remedial Investigation is not yet available for evaluation. Nevertheless, the authors of this document have concluded that this draft Feasibility Study could be prepared in reasonable fashion without these data.

### **3.2 Summary of Remedial Investigation Findings**

Section 3.2 presents a preliminary summary of the analytical results pertaining to the media sampled at the BROS Site. Also included, where appropriate, are discussions of the conclusions and interpretations developed from these findings.

#### **3.2.1 Lagoon**

The primary concern at the BROS Site is the 12.7-acre, open, unlined lagoon. This lagoon primarily contains an aqueous phase which has been contaminated by organic materials that appear to mainly consist of used motor oil. An oily layer floats on the surface of the lagoon and an oily sediment/sludge exists at the bottom of the lagoon. The lagoon is littered with miscellaneous debris, drums, and thousands of glass and plastic bottles. It has been rumored that tank cars, trucks, and other large objects are contained within the lagoon.

The analytical results for each of the lagoon phases sampled indicate that Polychlorinated Biphenyls (PCBs) are the primary contaminant of concern, especially with respect to lagoon overflows and contamination of local soils and surface waters, and with respect to disposal options for the lagoon wastes.

##### **3.2.1.1 Analytical Results**

###### **Oil Phase**

Results from the analyses of lagoon oil samples show the presence of PCBs at levels ranging from less than 100 parts per million (ppm) to 1380 ppm, with the average PCB concentration from the five samples being 667 ppm. Lagoon oil

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samples analyzed by subcontracted labs as part of the Treatability Study had PCB concentrations ranging from 105 ppm to 882 ppm, with an average PCB level of 624 ppm for the four Treatability Study samples. Appendix A presents more detail on the Treatability Study.

Other Hazardous Substance List (HSL) organics detected in the lagoon oil were limited to ethylbenzene and toluene. Ethylbenzene was observed at concentrations ranging from 11.5 ppm to 50.9 ppm. Toluene was detected at levels ranging from 35 ppm to 74 ppm.

Metals analysis of the lagoon oil (from the Treatability Study) indicates elevated concentrations of lead (160 to 1525 ppm), nickel (1.0 to 6.0 ppm), barium (40 to 180 ppm), chromium (2.0 to 29 ppm), and mercury (<0.15 to 0.25 ppm).

From these oil analyses, it is apparent that PCBs are the most critical contaminant present in the oil, especially in terms of evaluating disposal options. Also, it is apparent that the lagoon oil must be categorized as a PCB-contaminated waste containing greater than 500 ppm PCB.

#### Sediment Phase

Analytical results from the five lagoon sediment samples taken and analyzed as part of the NUS Remedial Investigation indicate that PCB levels in the sediment range from 190 ppm to 1400 ppm, for an average of 570 ppm. Results for the four sediment samples analyzed in the Treatability Study showed PCB concentrations ranging from 7.5 ppm to 2010 ppm, with an average of 512 ppm.

A full Hazardous Substance List scan was not performed on the lagoon sediment; however, Extractive Procedure (EP) Toxicity analyses were performed for metals, pesticides, and herbicides. No concentrations in excess of the EP Toxicity criteria were observed.

Metals analysis of the lagoon sediment, performed during the Treatability Study, revealed the presence of lead (368 to 760 ppm), chromium (12 to 25 ppm), nickel (9.2 to 31 ppm), and arsenic (0.53 to 7.6 ppm).

From the analytical results of the lagoon sediment, it is apparent that PCBs are the most critical sediment contaminant, especially in terms of identifying potential remedial alternatives. However, unlike the oil samples, there is some doubt as to whether the sediment must be categorized as containing greater than 500 ppm PCB, particularly with respect to the Treatability Study data (Table A-3 in Appendix A). Whether the sediment is categorized as containing greater than 500 ppm PCB or categorized as containing between 50 and 500 ppm PCB will be of utmost importance with respect to the method of disposal.

#### Aqueous Phase

Unlike the lagoon oil and sediment, no PCBs were detected in any of the five lagoon water samples. This observation is not surprising since PCBs have a very low solubility in water.

HSL organics analysis of the lagoon aqueous phase revealed the presence of a number of organic species, although substantial concentrations were not observed. Organics that were detected include: 2,4-dimethyl phenol (not detected or ND to 64 parts per billion or ppb); phenol (ND to 270 ppb); 4-methyl phenol (ND to 190 ppb); 2-methyl phenol (ND to 112 ppb); naphthalene (ND to 70 ppb); bis-(2-ethylhexyl)phthalate (ND to 24 ppb); butyl benzyl phthalate (ND to 50 ppb); phenanthrene (ND to 24 ppb); 2-methylnaphthalene (28 to 44 ppb); benzyl alcohol (ND to 90 ppb); benzene (34 to 86 ppb); 1,1,1 trichloroethane (ND to 19 ppb); 1,2-trans-dichloroethene (140 to 280 ppb); ethylbenzene (ND to 100 ppb); toluene (30 to 450 ppb); trichloroethene (ND to 11 ppb); acetone (510 to 1200 ppb); o-xylene (43 to 130 ppb); and 1,2-dichloropropane (ND to 16 ppb).

Inorganic analyses performed on the lagoon water as part of a study by CDM in July 1981 indicated that elevated levels of metals are present in the water. Metals

detected at significant concentrations included: cadmium (less than 100 to 110 ppb), chromium (240 to 2,800 ppb), copper (less than 10 to 3,020 ppb), lead (400 to 656,600 ppb), mercury (12 to 60 ppb), selenium (less than 10 to 168 ppb), and zinc (460 to 52,800 ppb).

From the analytical results of the aqueous phase of the lagoon, it is fairly obvious that the lagoon water would be detrimental to human health if ingested and detrimental to the local environment if discharged without treatment based on applicable water quality criteria. However, since PCBs were not detected in the aqueous phase, the aqueous phase is not expected to require disposal as a PCB-contaminated material even though it is in direct contact with the PCB-contaminated oil and sediment. In the past and at the present, the aqueous phase of the lagoon has not been identified as a PCB-contaminated waste; this policy is expected to apply to further lagoon water disposal actions.

#### 3.2.1.2 Lagoon Characterization

If the lagoon is allowed to remain unattended, and the lagoon dikes do not fail, the lagoon level rises with each rainfall. The reason for this is threefold: (1) the lagoon has no provision for surface water discharge, (2) the oily layer floating on the lagoon prevents evaporation of lagoon water, and (3) the oily sediment/sludge at the bottom of the lagoon acts to partially seal liquid in the lagoon. Therefore, any precipitation that falls on the lagoon is "trapped," increasing the amount of the aqueous phase. Consequently, if no action is taken on the lagoon, the lagoon level would continue to rise, eventually overtopping the dikes and spreading contaminated material over the surrounding area. Even if the lagoon level is monitored and controlled, one of the dikes could fail, allowing the lagoon contents to contaminate the surrounding areas.

As a result of the tendency for the lagoon level to rise, and because in the past the lagoon dikes were raised whenever it appeared as though the lagoon were going to overflow, the lagoon surface has been at a level that was as much as 10 feet above the water table. (As of July 1984, lagoon water removal and treatment by EMPAK,

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Inc. has lowered the lagoon surface to a level about 5 feet above the water table). This hydraulic head from the lagoon acts as a driving force, "pushing" the contaminated lagoon water and wastes into the groundwater. The semi-impermeable oily sediment at the bottom of the lagoon helps to prevent infiltration of lagoon water into the local groundwater; nevertheless, groundwater mounding was observed around the lagoon during the NUS Remedial Investigation. This mounding indicates that the contaminated lagoon water is, to some degree, recharging and therefore contaminating the local groundwater.

In an effort to prevent any future overflows and to reduce or eliminate the hydrostatic driving force of the lagoon, the Army Corps of Engineers awarded a contract to EMPAK, Inc., of Pennsauken, New Jersey, to remove and treat lagoon aqueous phase liquid. Using a treatment system design developed by Camp Dresser and McKee, Inc. (CDM), EMPAK built the treatment facility and began actively treating lagoon aqueous phase in November 1983. The system was shut down for the winter in December 1983 and was restarted on February 27, 1984. Optimum treatment plant operation seems to be about 200 gallons per minute (gpm) of effluent, which is discharged to nearby Little Timber Creek. From the time that the plant was brought into production until the time of this writing (July 1984), the lagoon level has been dropped by about 5 feet and over 25 million gallons of lagoon water has been treated. EMPAK's contract with the Army Corps of Engineers calls for the lagoon level to be dropped down to the level of the water table, or for 35 million gallons (plus or minus 15 percent) of lagoon water to be treated, whichever comes first. EMPAK feels that this could be accomplished by August 1984.

The profile of the lagoon bottom was also investigated by NUS during the Remedial Investigation. The lagoon profile was developed from 72 depth soundings that were taken when the lagoon sampling was being performed (along the four line-traverses). These depth sounding data were input into a computer graphics

program that was developed by Radian Corporation<sup>1</sup>. Figure 3-1 shows the three-dimensional portrayal of the lagoon that was developed by the graphics program.

From this portrayal, and from the contour lines drawn by the graphics program, the volume of liquid in the lagoon was calculated. When the lagoon level is at an elevation of 14 feet MSL, the volume of the liquid contents is calculated to be about 36,000,000 gallons (including both water and oil).

### 3.2.2 Groundwater

This section presents a discussion of the findings related to the local groundwater. First is a discussion of the analytical results obtained from the sampling of NUS and EPA monitoring wells. Next, there is a discussion of the residential well sampling data provided by the EPA. Finally, there is a presentation of the results from groundwater flow modeling as related to plume migration under various conditions of groundwater extraction and lagoon surface elevation.

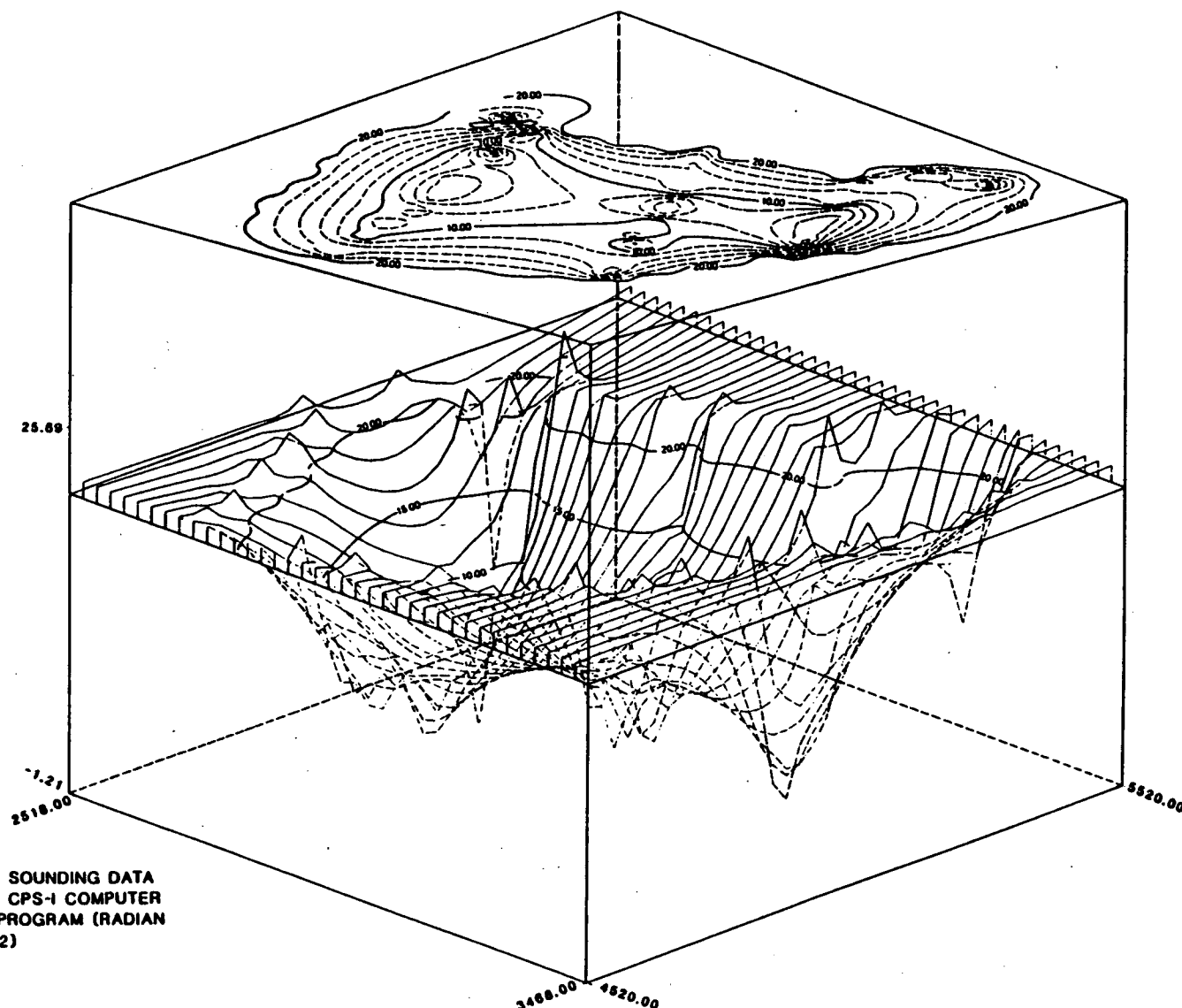
#### Monitoring Wells

Sixteen NUS monitoring wells and eight EPA monitoring wells were sampled in November 1983 and January 1984. The validated results from these samplings have been received and are available for evaluation, with the exception of the November 1983 inorganics data which have not been validated. These results confirm the presence of a plume of groundwater contamination emanating from the BROS lagoon in at least three locations, as was suggested by the electromagnetic profiling performed during the geophysical investigation. The general location of these plumes, as well as the locations of the monitoring wells, is shown on Drawing 0707.22-01, which is in a pocket at the back of this report.

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<sup>1</sup> CPS-1 Computer Graphics Program, Radian Corporation, Austin, Texas, Copyright 1982.

3-12



VERTICAL DATUM IS ARBITRARY.

SOURCE: NUS DEPTH SOUNDING DATA  
INPUT INTO CPS-1 COMPUTER  
GRAPHICS PROGRAM (RADIAN  
CORP., 1982)

**BROS LAGOON - ISOMETRIC NET PLOT**  
**BRIDGEPORT RENTAL & OIL SERVICES, LOGAN TWP., NJ**

FIGURE 3-1



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The groundwater monitoring results are presented in greater detail in the Remedial Investigation Report.

Wells adjacent to the south side of the lagoon (EPA-101 and well cluster S-1A, S-1B, and S-1C) showed organic contamination in the form of methylene chloride at levels ranging from 11 to 74 ppb in three wells and at a level of 11,000 ppb in well S-1B. Other organics observed included one detection of trichloroethene at 110 ppb in well S-1B, one positive detection of bis(2-ethylhexyl)phthalate at 43 ppb in well S-1A, and a measurement of 6,200 ppb for petroleum hydrocarbons in well EPA-101. Pesticides were also detected in these wells; these pesticides included aldrin (0.19 ppb), dieldrin (0.46 ppb) and endrin (0.52 ppb). It should also be noted that approximately 1/4 inch of oil was observed floating on the surface of the water table in well S-1A.

Inorganics observed at significant concentration in the monitoring wells directly south of the lagoon included iron, manganese, zinc, and lead. Secondary drinking water standards were exceeded in all monitoring wells directly south of the lagoon for iron (5,150 to 14,600 ppb), manganese (315 to 1,740 ppb), and zinc (12,700 to 43,000 ppb). The primary drinking water standard for lead was not exceeded, with lead concentrations ranging from 5 to 45 ppb. It should be noted that observed zinc concentrations may be, in part, attributable to the galvanized pipe used in the NUS well construction.

Monitoring well S-6, which is located south-southeast of the BROS lagoon and is separated from the lagoon by Swindell Pond, showed the presence of 1,1,1-trichloroethane at 12 ppb and methylene chloride at 10 ppb. Petroleum hydrocarbons were observed at a concentration of 15,500 ppb in well S-6. Aldrin (0.23 ppb), dieldrin (0.61 ppb), and endosulfan I (0.23 ppb) were also observed in samples from well S-6. Inorganics detected in well S-6 included iron at 2,700 ppb, manganese at 90 ppb, zinc at 9,930 ppb, and lead at 30 ppb.

The groundwater directly north-northwest of the lagoon exhibited higher levels of contamination than the groundwater south of the lagoon, as is indicated by the

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results from well cluster S-3 (Wells S-3A, S-3B, and S-3C). Organics detected in the S-3 wells include: benzene (not detected or ND to 360 ppb), methylene chloride (15 to 10,000 ppb), toluene (ND to 1,000 ppb), 2-butanone (ND to 34 ppb), 4-methyl-2-pentanone (ND to 1,500 ppb), bis(2-chloroethyl)ether (ND to 72 ppb), isophorone (ND to 26 ppb), benzyl alcohol (ND to 600 ppb), and hexachloroethane (ND to 80,000 ppb). Pesticides found in well S-3 include dieldrin (ND to 1.12 ppb), endosulfan I (ND to 0.47 ppb), and heptachlor (ND to 0.53 ppb). Well S-3A (the shallow well of the cluster) consistently exhibited the worst water quality in the S-3 cluster. Surprisingly, well S-3B (the intermediate well) showed the best water quality of the cluster. Inorganics detected in the S-3 cluster included iron (30,100 to 118,000 ppb), manganese (570 to 2,430 ppb), zinc (570 to 116,000 ppb), and lead (10 to 70 ppb). Well S-3A was highest in iron and lead levels; well S-3C was highest in the other inorganics.

Moving farther to the northwest, away from the lagoon, monitoring wells EPA-103, EPA-105, and EPA-106 showed a significant improvement in the groundwater quality over the contamination observed in the S-3 well cluster. The only organics observed in these wells were 1,2-trans-dichloroethene (ND to 5 ppb), methylene chloride (9 to 57 ppb), and acetone (ND to 21 ppb). One detection of aldrin (0.15 ppb) was made in well EPA-105. Inorganics observed in wells EPA-103, 105, and 106 included iron (6,300 to 23,600 ppb), manganese (45 to 10,500 ppb), zinc (15,900 to 65,500), and lead (15 to 80 ppb).

To the west of the BROS Site, the groundwater quality was comparable to that observed in the wells directly south of the site. Monitoring wells S-4 and EPA-102 (located roughly in the center of the Gaventa peach orchard) showed the presence of methylene chloride (12 to 3,600 ppb), 1,2-trans-dichloroethene (ND to 8 ppb), toluene (ND to 74 ppb), trichloroethene (ND to 8 ppb), and bis(2-ethylhexyl)phthalate (ND to 12 ppb). No pesticides were observed in well S-4, although dieldrin (0.39 ppb), endosulfan I (0.27 ppb), and heptachlor (0.42 ppb) were found in well EPA-102. Inorganics detected in the groundwater west of the site included iron (3,100 to 15,000 ppb), manganese (180 to 915 ppb), nickel (ND to 40 ppb), zinc (240 to 29,800 ppb), and lead (10 to 100 ppb).

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The groundwater east and northeast of the BROS lagoon showed substantial organic contamination, with the groundwater east of the lagoon exhibiting the poorest quality. Well cluster S-2 (northeast of the lagoon) and well cluster S-11 (east of the lagoon) showed the following contaminants: benzene (ND to 800 ppb), chlorobenzene (ND to 130 ppb), 1,1,1 trichloroethane (ND to 840 ppb), 1,1,2,2-tetrachloroethane (ND to 430 ppb), 1,2-trans-dichloroethene (ND to 520 ppb), ethylbenzene (4 to 490 ppb), methylene chloride (44 to 6,900 ppb), toluene (28 to 3,100 ppb), trichloroethene (10 to 9,000 ppb), acetone (ND to 73,000 ppb), 2-butanone (ND to 4,900 ppb), 4-methyl-2-pentanone (ND to 9,600 ppb), 2,4-dimethylphenol (ND to 180 ppb), benzoic acid (ND to 5,600 ppb), 2-methylphenol (ND to 380 ppb), 4-methylphenol (ND to 510 ppb), bis(2-chloroethyl)ether (86 to 990 ppb), isophorone (ND to 2,800 ppb), bis(2-ethylhexyl)phthalate (ND to 110 ppb), and benzyl alcohol (ND to 5,200 ppb). Pesticides detected in S-2 and S-11 include dieldrin (0.52 to 1.15 ppb), endosulfan I (ND to 0.32 ppb) and heptachlor (ND to 0.60 ppb). In addition, approximately 5 inches of oil was observed floating on the water table in well S-11A.

Inorganics detected in the groundwater east and northeast of the lagoon included iron (53,700 to 639,000 ppb), manganese (1,830 to 6,230 ppb), nickel (ND to 400 ppb), vanadium (ND to 4,200 ppb), zinc (7,490 to 310,000 ppb), and lead (20 to 120 ppb).

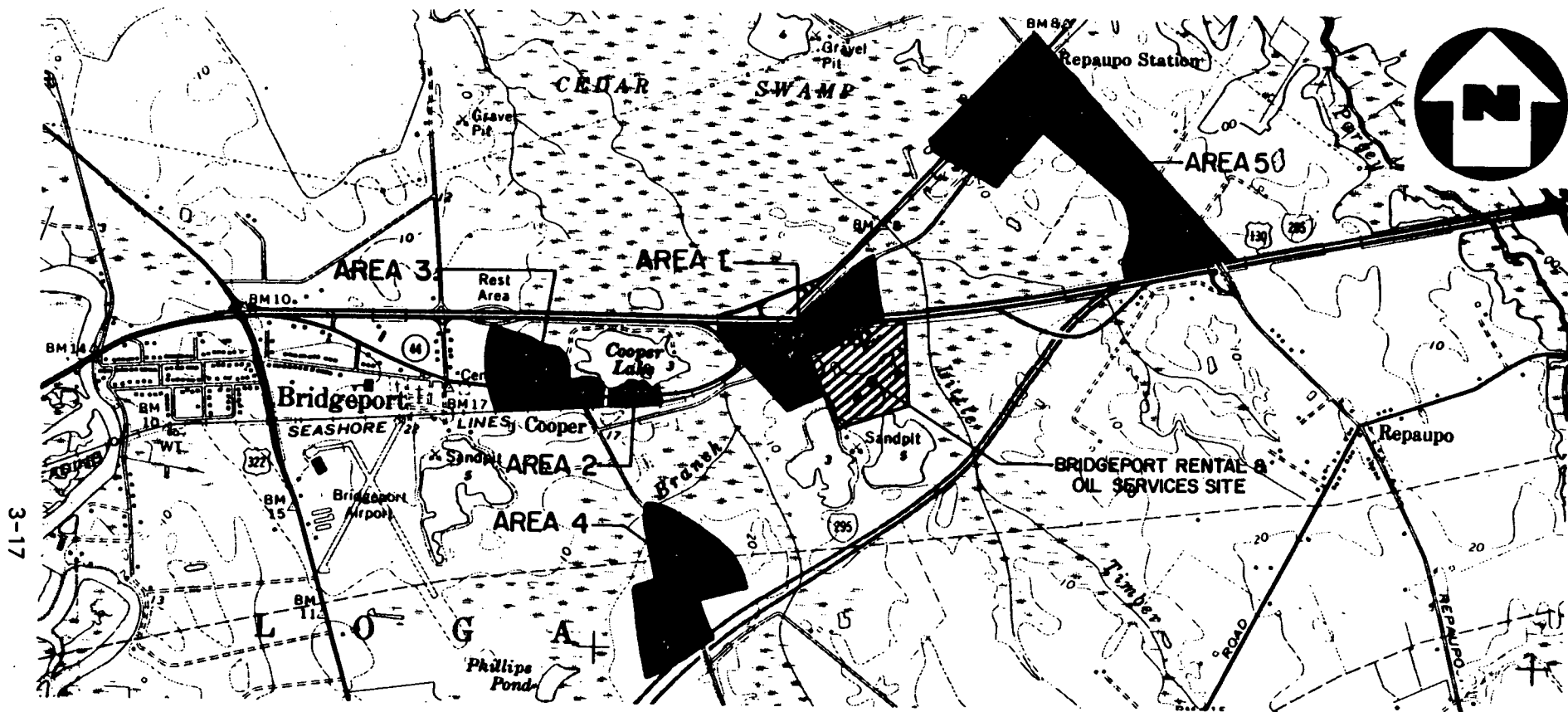
In summary, it appears as though there is a plume of contaminated groundwater emanating from the lagoon in at least three places. The contaminant plume to the south was the least contaminated, followed by the plume exiting to the northwest. The plume exiting to the east-northeast from the lagoon showed the poorest groundwater quality. From the available data (for the plumes to the south and to the northwest of the lagoon), it appears as though the groundwater plumes have not spread far from the lagoon, as is evidenced by a substantial improvement in groundwater quality at a distance of 400 to 600 feet away from the lagoon. The reasons that plume migration is limited are as follows: (1) the water table gradient is very flat beyond the influence of the lagoon; (2) no high-volume pumping wells

are located nearby the site; and (3) the plume to the east-northeast of the lagoon discharges to Little Timber Creek Swamp.

### Residential Wells

Information provided by the EPA on the quality of residential well water in the BROS Site vicinity indicates that contamination of residential wells has occurred. Drawing 0707.22-01 shows the locations of some of the residential wells tested by the EPA. Drawing 0707.22-01 is provided in a pocket at the back of this report. The general locations of all of the wells tested by the EPA are shown in Figure 3-2.

Ten wells in the vicinity of the BROS Site are now affected, or are expected to become affected in the future, by the groundwater contamination emanating from the BROS Site. These wells are located west, northwest, and north of the site (Area 1 in Figure 3-2) and are referred to by the following names: Keller, Pepper Industries, Fish Diesel Repair, Byrnes, Lindle, Newton, Cahill, Hillman, Fryberger, and Bell. Of these wells, the Keller well has shown the highest level of organic contamination in the form of 1,2-trans-dichloroethene (30 to 62 ppb), tetrachloroethene (8 to 20 ppb), trichloroethene (130 to 290 ppb), and vinyl chloride (ND to 11 ppb). The Keller well has been fitted with a carbon filtration unit which has demonstrated satisfactory removal of these organic contaminants. The Pepper Industries well has shown some contamination, which is primarily trichloroethene (2 to 8.4 ppb). Benzene (ND to 6.4 ppb), 1,1,1-trichloroethane (ND to 4.5 ppb), and tetrachloroethene (ND to 2.7 ppb) were also detected in the Pepper Industries well. Low levels of organic contamination were also detected in the group of three residential wells located about 1,000 feet northwest of the site. The contamination detected in these three wells consisted of trichloroethene (ND to 2 ppb) in the Cahill well, 1,2-dichloropropane (ND to 27 ppb) in the Lindle well, and toluene (ND to 4.7 ppb) and benzene (ND to 2 ppb) in the Newton well. The five remaining residential wells (Byrnes, Fish Diesel Repair, Hillman, Freyberger, and Bell) that are believed to be potentially influenced by the groundwater contamination exiting from the BROS Site have not yet shown any organic contamination. Possible



	AREA 1		AREA 2	AREA 3	AREA 4	AREA 5
RESIDENTIAL	BELL	HILLMAN	AUGUST	LLOYD	BECKETT	GAVENTA
WELL OWNERS	BYRNES	KELLER	MIKULETSKY	LONG	COCO	NUNES
IDENTIFIED	CAHILL	LINDLE	TREW	MUNTZ	PANSERRA	WACHTER
BY AREA	FISH DIESEL REPAIR	NEWTON	WILSON	QUATTROCHI	PARISI	WEITZ
	FRYBERGER	PEPPER IND.		RETKOVIS	STULL	
				SEIVERD		

FIGURE 3-2

GENERAL LOCATION OF RESIDENTIAL WELLS SAMPLED BY THE E.P.A.  
BRIDGEPORT RENTAL & OIL SERVICES, LOGAN TWP., NJ

SCALE: 1"=2000'

groundwater mounding effects resulting from rainwater runoff from Route 130 may prevent northerly migration of contaminated groundwater from the BROS Site.

Four residential wells (August, Mikuletsky, Trew, and Wilson) that are located about 2,400 feet west of the BROS Site (Area 2 in Figure 3-2) have also shown organic contamination. The Mikuletsky well has shown the highest level of contamination of these four wells with the following organics being detected: benzene (ND to 9.3 ppb), chlorobenzene (5 to 13 ppb), 1,2-dichloroethane (55 to 93 ppb), 1,2-trans-dichloroethene (130 to 370 ppb), tetrachloroethene (18 to 55 ppb), trichloroethene (17 to 40 ppb), and vinyl chloride (17 to 170 ppb). The August well also showed substantial contamination in the form of trichloroethene (100 to 210 ppb) and some contamination from 1,2-trans-dichloroethene (7.1 to 20 ppb). The Trew well showed only trichloroethene contamination at levels ranging from 3.3 to 6.7 ppb. The Wilson well exhibited tetrachloroethene contamination ranging from ND to 11 ppb. The August well and Mikuletsky well are both fitted with carbon filtration units. The unit on the August well appears to be performing adequately based on the analysis of water samples taken before and after the carbon filter. The Mikuletsky carbon filter also appears capable of removing organics to a level within New Jersey State Guidelines; however, breakthrough of the Mikuletsky carbon unit appears to occur more quickly than for the August carbon unit, based on at least one sample of the effluent which exceeded State Guidelines for volatile organics content. This situation indicates that the carbon in the Mikuletsky unit should be replaced more often.

Although these four wells in Area 2 show contamination with organics similar to those detected near the BROS Site, an evaluation of the analytical data and the hydrogeological data has led to the conclusion that these wells are being primarily contaminated by some other source. For example, 1,2-dichloroethane and vinyl chloride were not detected in any BROS monitoring wells, and significant levels of 1,2-trans-dichloroethene (i.e., in excess of 50 ppb) were detected only in the S-11 monitoring well cluster located on the east side of the lagoon. Also, an evaluation of the monitoring well chemical data has indicated that the groundwater quality improves substantially within a distance of about 800 feet from the lagoon. On the

other hand, the Mikuletsky well (about 2,400 feet west of the BROS lagoon) shows substantial concentrations of 1,2-dichloroethane, vinyl chloride, and 1,2-trans-dichloroethene. Furthermore, there are two groundwater discharge zones (Cedar Creek Swamp and Cooper Lake) located between these four wells and the BROS Site. For these reasons, it is believed that the four wells located about 2,400 feet west of the BROS Site are being contaminated by some other source.

Five residential wells located to the southwest of the site (Stull, Panserra, Parisi, Beckett, and Coco) were sampled and no organic contamination was found (Area 4 in Figure 3-2). Since these wells are upgradient of the BROS Site (based on the regional groundwater flow direction), have not demonstrated organic contamination, and are separated from the site by two groundwater discharge zones (Cedar Creek Swamp and Gaventa Pond), it is believed that these wells are not influenced by the groundwater contamination at the BROS Site.

A number of wells located between 3,000 and 4,000 feet west of the site were also tested (Area 3 in Figure 3-2). These wells are believed to be too far from the BROS Site to be influenced by groundwater contamination coming from the site, based on the reasoning previously used for the Mikuletsky well and other wells in that area. Contamination detected in those wells located 3,000 feet or more from the site is expected to be coming from some other source.

Similarly, several wells located between 3,000 and 4,000 feet northeast of the site (Area 5 in Figure 3-2) are believed to be beyond the influence of groundwater contamination from the BROS Site. Additionally, these wells are separated from the site by Little Timber Creek and Little Timber Creek Swamp, which are groundwater discharge zones.

#### Groundwater Modeling

Various calculations and models for the groundwater system in the vicinity of the BROS Site were performed using the aquifer characteristics defined during the Remedial Investigation. This discussion presents the relevant information

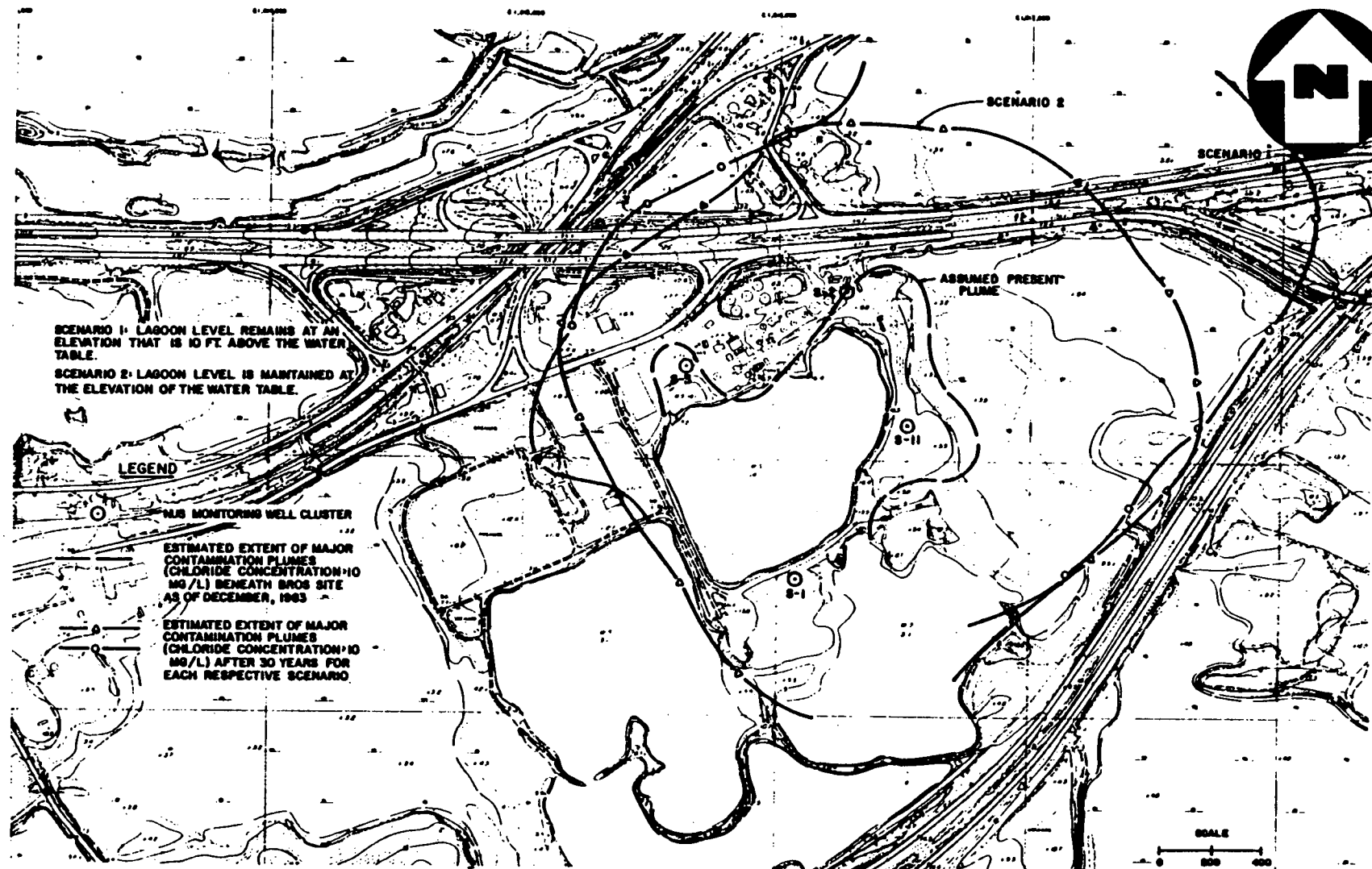
generated by these calculations and models. Appendix B provides further detail on the methods used for this modeling.

A groundwater flow model (Prickett-Lonquist Aquifer Simulation Model) was used to simulate the transmissivity of the oily sludge in the bottom and along the sides of the BROS lagoon. The transmissivity of the sludge was varied over several computer runs until the simulated head in the lagoon and surrounding aquifer matched the heads observed in the field.

A solute transport model (RANDOM WALK) was used to simulate contaminant transport in groundwater beneath the site. Three contaminant migration scenarios were simulated:

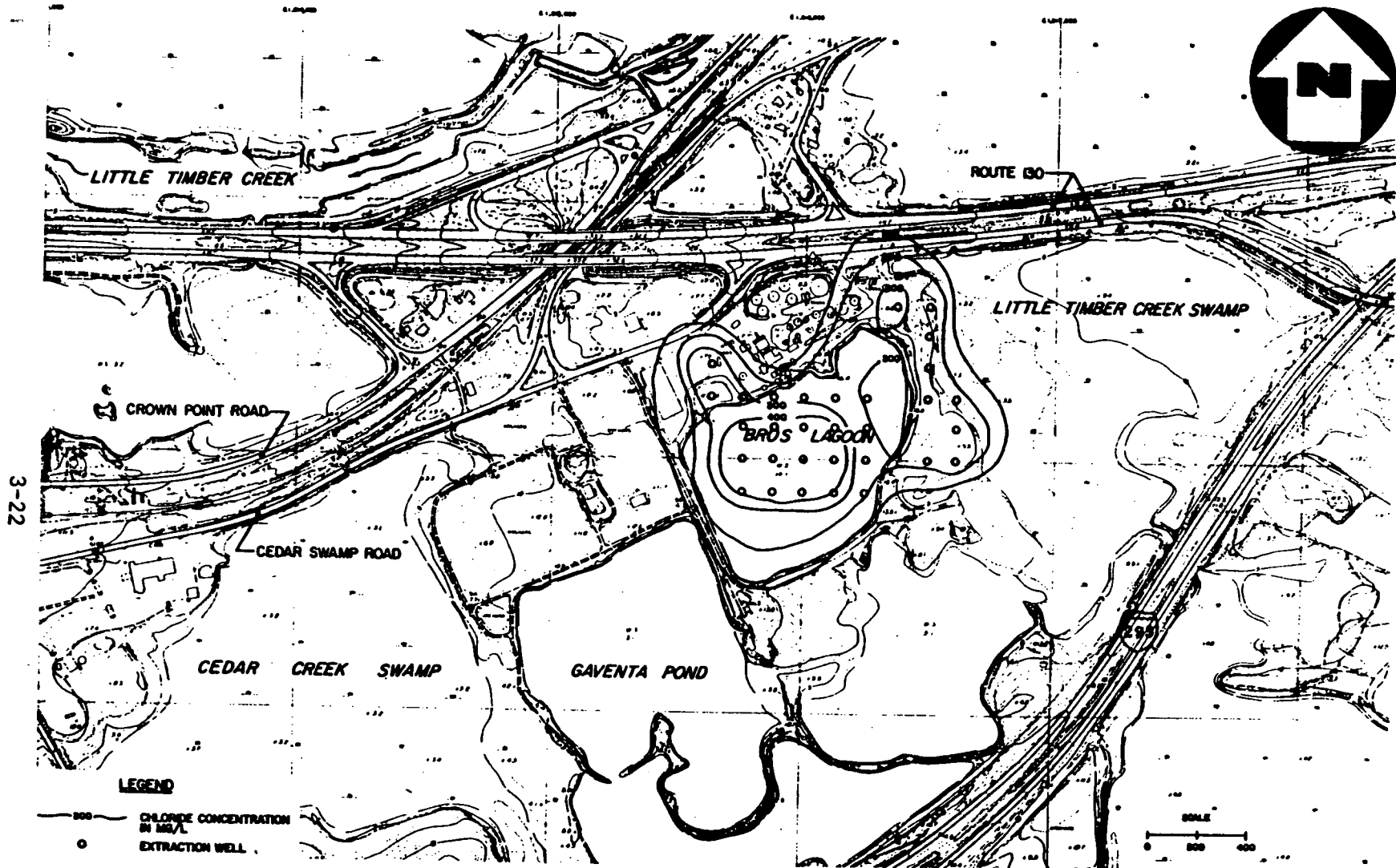
- Scenario 1 (Lagoon Mounding) - This scenario models the groundwater contaminant dispersion over a 30-year period, assuming that the lagoon surface remains at a level 10 feet above the water table.
- Scenario 2 (Plume Dispersion) - This scenario models the groundwater contamination dispersion over a 30-year period, assuming that the lagoon dikes are removed and the lagoon surface is maintained at the level of the water table.
- Scenario 3 (Extraction Wells) - This scenario models the movements of contaminants in response to various configurations of extraction wells designed to pump the contaminants out of the aquifer.

Figure 3-3 shows the extent of plume migration as modeled under Scenario 1 and Scenario 2. Figure 3-4 illustrates the plumes of groundwater contamination (based on chloride concentration) at the present time before any groundwater renovation is attempted. Finally, Figure 3-5 presents the simulated degree of groundwater cleanup that would be achieved under Scenario 3, in which 32 extraction wells are pumped at 20 gpm for five years.



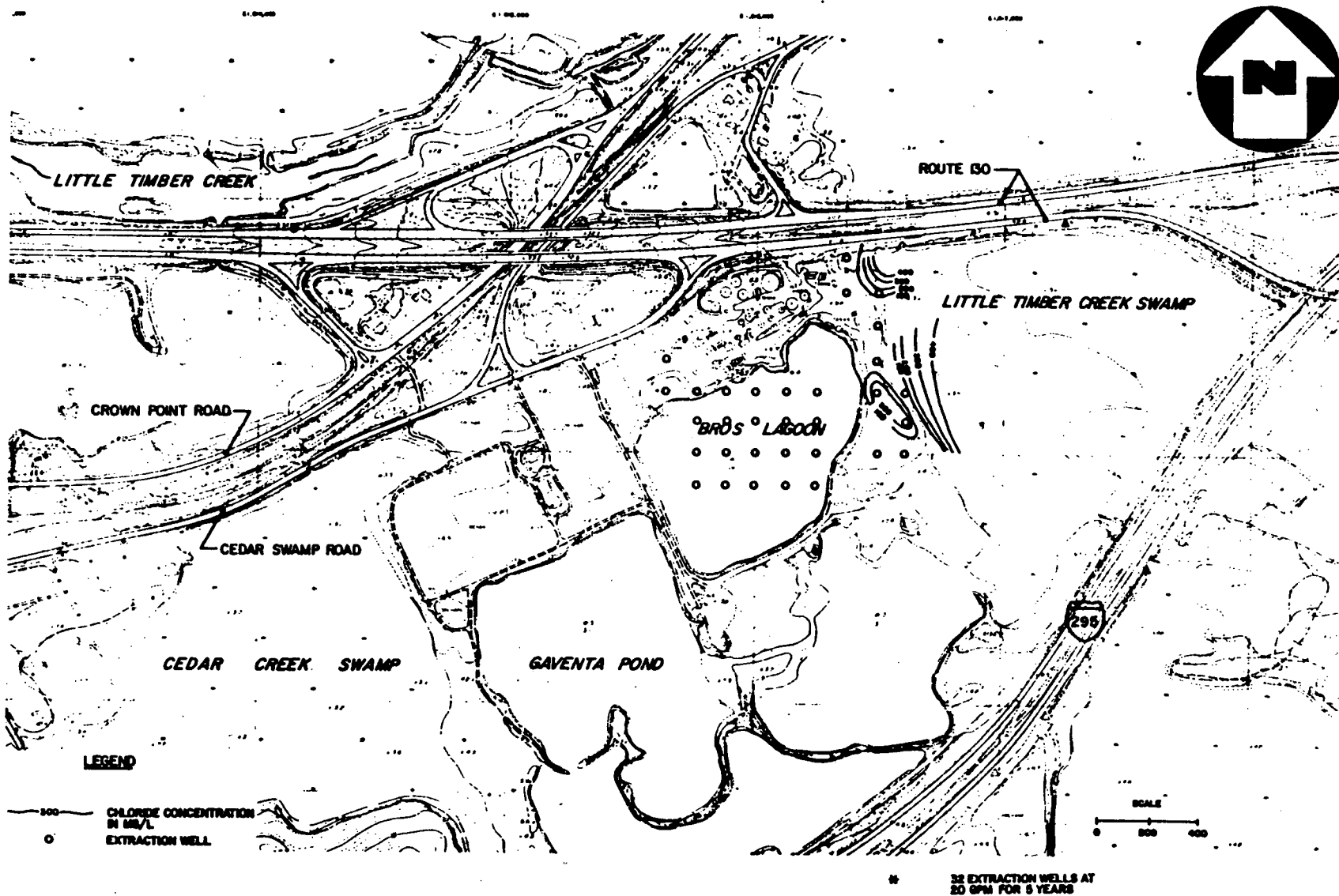
**GROUNDWATER MODELING OF CONTAMINANT MIGRATION  
BRIDGEPORT RENTAL & OIL SERVICES, LOGAN TWP., NJ**

**FIGURE 3-3**



**CONTAMINANT CONCENTRATION PRIOR TO PUMPING (SIMULATED)**  
**BRIDGEPORT RENTAL & OIL SERVICES SITE, LOGAN TOWNSHIP, NJ**

3-23



**CONTAMINANT CONCENTRATION AFTER PUMPING (SIMULATED) \***  
**BRIDGEPORT RENTAL & OIL SERVICES SITE, LOGAN TOWNSHIP, NJ**

The groundwater models were based on the following assumptions.

- Flow Model

The aquifer was modeled as a two-dimensional, non-steady state, heterogeneous, and anisotropic aquifer with unconfined conditions. The transmissivity of the oily sludge in the lagoon was varied over several simulations in order to recreate the mounding effects of the lagoon. Recharge boundaries (such as ponds) and groundwater mounding from topographic high points were also simulated.

- Transport Model

The transport model was a two-dimensional, homogeneous, and isotropic simulation under unconfined conditions. In order to simulate a worst-case situation, no retardation of contaminant migration was assumed to have occurred from interaction between the contaminant and the groundwater or aquifer. The concentrations of chlorides in the monitoring wells were used to simulate contaminant dispersion at the beginning of the model.

The actual contaminants are mostly organic chemicals; therefore, some interaction may occur between the contaminants and the groundwater or aquifer.

The models were run on a COMPAQ microcomputer using MS-DOS in Microsoft BASIC.

The results of the flow model indicate that the sludge in the lagoon is nearly impermeable. The low permeability maintains the head in the lagoon about 10 feet above the surrounding water table.

The solute transport models (Figure 3-3) indicate that if the lagoon mound is left in place, contaminants will migrate approximately 2000 feet northeast into Little

Timber Creek over a 30-year period. Reducing the head in the lagoon to that of the surrounding water table will reduce the extent of contaminant migration from 2000 feet to about 500 feet over the same 30-year period. The extraction well model (Figure 3-5) indicated that 32 wells pumping at 20 gpm each (640 gpm total) over a five-year period would reduce the concentration of chlorides in the groundwater from over 400 mg/l to background levels (10 to 50 mg/l), an 88 to 98 percent reduction in contaminant concentration. (The concentration reduction for the contaminants of concern in the groundwater, i.e., organic chemicals, may be different than was modeled for chloride since some interaction between organic contaminants and the aquifer may occur).

### 3.2.3 Surface Water/Sediment

The highest contaminant concentrations detected in any surface water sample were for a sample (SW-02 in Drawing 0707.22-01) taken northeast of the site in Little Timber Creek Swamp (43 mg/l organic carbon, 4400 mg/l oils, 330 µg/l methylene chloride, and 34 µg/l total PCB). A sediment sample (S0-02 in Drawing 0707.22-01) taken from the same location also showed the highest level of contamination with a PCB concentration of 2.5 milligrams per kilogram and an oil and grease content of 27 percent. This contamination in the surface water and sediment northeast of the site appears to be the result of lagoon overflows and dike breaches in this area in the past. The Gaventa and Swindell Ponds, located adjacent to the lagoon, did not show significant contamination, although the threat of contamination in these ponds is great because of their proximity to the BROS lagoon.

There is no doubt that the BROS lagoon poses a threat to the local surface waters and sediments. Currently, direct contaminant migration into local surface waters appears to be the result of breaching or overflowing of the lagoon dikes. Indirect contamination of the local surface waters appears to be the result of contaminated groundwater discharging into these surface water bodies. Fortunately, the swamps surrounding the BROS Site are favorable for the biodegradation of organic contaminants, if the loading is small (with the exception of PCBs which tend to be

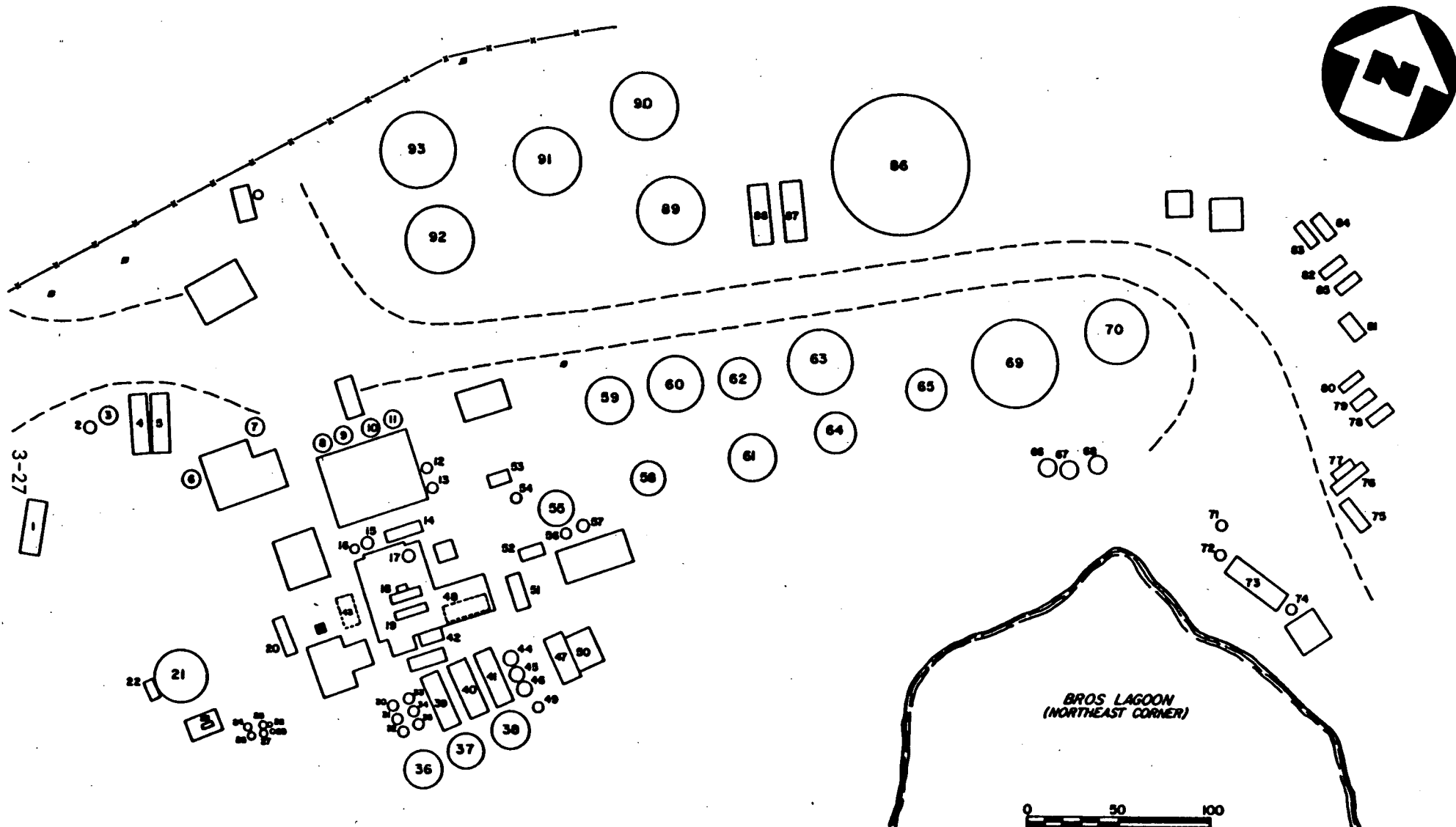
resistant to biodegradation). Therefore, if these swamps are contaminated, the organic contaminants may biodegrade. PCBs released to surface waters would not tend to migrate with the water since they are immobile and highly insoluble in water and, instead, prefer to stay in the oil phase or adsorb to sediments. However, erosion of sediments or large oil releases could cause PCB migration. A major failure in the lagoon dike would have disastrous effects on the local surface water and sediment--the release of vast quantities of PCB-contaminated oil into the environment. Such a release could also effect the local groundwater by infiltration.

From the available information, it appears as though offsite surface waters and sediments have not been contaminated to a great degree. However, in its present state, the BROS lagoon poses a real and considerable risk to the offsite surface water and sediment. Unless some action is taken with respect to the lagoon, reducing or eliminating the threat of lagoon overflows and dike failure, substantial and potentially irreversible damage to the local environment could occur in the future.

With respect to the offsite surface waters and sediment, a limited-scale surficial cleanup of areas where oily sediments and/or water are observed to be present may be appropriate. Drawing 0707.22-01 delineates an area northeast of the lagoon which would be a candidate for surficial cleanup.

#### **3.2.4 Tank Farm**

Sampling of the approximately 90 tanks in the BROS tank farm was conducted by NUS in August 1983. Samples of each discernable phase were taken from the tanks that contain waste, and scrape or wipe samples were taken from the empty tanks. CDM also performed tank sampling in July 1982. The results from the CDM sampling program were used to supplement the NUS results in those places where data gaps existed. Figure 3-6 shows the locations of the tanks in the tank farm and gives the identification numbers assigned by NUS during the RI.



TANK AND DRUM LOCATION  
BRIDGEPORT RENTAL & OIL SERVICES, LOGAN TWP., NJ

Table 3-1 presents a summary of the results from the tank farm sampling. Only those tank waste phases that were estimated to be greater than 1,000 gallons in volume are included in Table 3-1. The tank wastes not summarized in Table 3-1 (because they were estimated to be less than 1,000 gallons in volume) are estimated to total only about 10,000 gallons.

The information contained in Table 3-1 is used in subsequent sections of this Feasibility Study to determine appropriate tank waste disposal techniques. For example, aqueous liquid wastes that do not contain appreciable quantities of HSL organics (especially chlorinated solvents and PCBs) may be acceptable for disposal at an industrial wastewater treatment facility. On the other hand, oils and sludges may require incineration, and if the PCB content of the waste exceeds 50,000  $\mu\text{g/kg}$ , then disposal at a PCB-approved incinerator may be required.

Based on the information presented in Table 3-1, it is evident that most of the aqueous liquid wastes may be suitable for disposal at a wastewater treatment facility. The oils and sludges are assumed to require incineration; however, based on the relatively low PCB content of most of these wastes (i.e., less than 50,000  $\mu\text{g/kg}$ ) the oils and sludges may be acceptable for incineration at a facility approved to dispose of organic solvents. The exception is the waste from tank 69. As shown in Table 3-1, the oil phase and sludge phase from tank 69 contain greater than 50,000  $\mu\text{g/kg}$  of PCBs (based on analytical results provided by CDM). These levels of PCBs may require that the oil and sludge from tank 69 be incinerated at a PCB-approved incinerator. Furthermore, the aqueous phase from tank 69, although low in PCBs, may also require incineration at a PCB-approved facility because this aqueous phase is trapped between two phases containing high levels of PCBs.

Detailed analyses of the tank wastes are presented in a separate database document.

TABLE 3-1

**GENERAL PHYSICAL AND CHEMICAL CHARACTERIZATION OF TANK CONTENTS  
BROS SITE, LOGAN TOWNSHIP, NEW JERSEY**

<u>NUS Tank Number<sup>1</sup></u>	<u>Sampled Phase</u>	<u>Estimate Volume of Sampled Phase (Gallons)</u>	<u>Total HSL<sup>2</sup> Organics (µg/g)</u>	<u>Chlorinated Hydrocarbon Solvents (µg/g)</u>	<u>PCB (µg/kg)</u>
1	Sludge	2,600	ND	ND	ND
6	Sludge	1,100	72	ND	ND
15	Aq. Liq.	1,500	ND	ND	ND
18	Aq. Liq.	2,500	2,502	180	11
18	Sludge	2,500	4,615	430	4.7
21	Aq. Liq.	22,800	ND	ND	ND
30	Oil	4,200	88	ND	300
31	Oil	3,400	2.5	ND	87
36	Oil	11,200	40	ND	940
37	Oil	4,800	9,087	687	66
38	Oil	2,600	537	29	28
39	Oil	3,900	385	ND	ND
50	Aq. Liq.	18,900	ND	ND	ND
51	Oil	2,300	307	65	113
52	Oil	3,200	1,544	ND	217
53	Oil	1,300	225	60	150
54	Solid	1,500	ND	ND	ND
55	Oil	9,500	1,739	105	3,900
56	Oil	1,700	33	ND	1,200
60	Oil	11,400	2,250	115	ND
63	Oil	216,500	3,782	30	1,240
66	Oil	1,700	255	ND	ND
68	Aq. Liq.	1,800	11,600	ND	ND
69 Top <sup>3</sup>	Oil	310,000	258	50	128,000
69 mid <sup>3</sup>	Aq. Liq.	90,000	15	ND	ND
69 Bot <sup>3</sup>	Sludge	13,000	955	290	330,000
70	Aq. Liq.	6,000	ND	ND	ND
82	Oil	3,300	142	30	ND
87	Aq. Liq.	1,800	ND	ND	ND
88	Aq. Liq.	1,800	2,500	ND	ND
88	Oil	7,100	ND	ND	ND

<sup>1</sup> Tank locations are shown on Figure 3-24.

<sup>2</sup> HSL = Hazardous Substance List.

<sup>3</sup> Tank Number 69 was not sampled in the NUS RI; reported volumes and results are from previous sampling performed by CDM in July 1982.

Source: NUS Remedial Investigation, 1983.

### 3.2.5 Air

Ambient air monitoring during the NUS Remedial Investigation was limited to monitoring with an organic vapor analyzer. Although volatile organic species were detected in the lagoon, no volatile organic readings above background were observed in the ambient air. However, one potential air contamination problem has been identified, although it has not yet been observed. This air contamination problem is the potential for PCB-laden dust to become airborne and migrate off site. However, this situation is unlikely, especially if the lagoon oil partially coats the exposed sediment as the lagoon level fluctuates; thereby preventing the sediment from drying and becoming windborne.

### 3.3 Site Remediation Objectives

From the evaluation of the Remedial Investigation results for the BROS Site, it is apparent that several areas of the site and site vicinity are worthy of consideration for remedial action. Each of these areas is discussed below.

Analyses of the three phases of the BROS lagoon indicate that the lagoon poses a serious threat to the health and welfare of the general public and to the environment. The lagoon oil and sediment are laden with PCBs at concentrations above 500 ppm, as well as other organics, and the lagoon water contains significant concentrations of a variety of HSL organics. Without ongoing lagoon-water treatment, the lagoon level continues to rise from rainwater input, threatening to overflow or breach the existing dikes and thereby causing substantial contamination of the local environment. Furthermore, the lagoon wastes are in contact with the underlying aquifer, which is used for potable water, and the lagoon is contaminating the groundwater. For these reasons, it is obvious that the BROS lagoon deserves consideration for remedial action. Included in any subsequently developed lagoon cleanup alternatives will be the surficial cleanup of about three acres of land adjacent to the east-northeast side of the lagoon. This land is covered with a thin layer of oily material that seems to have been deposited by past lagoon overflows and/or dike breaches along this side of the lagoon. This

surficial cleanup is expected to be small in scope and small in cost as compared to the remainder of the lagoon cleanup activities. Currently, this surficial cleanup is scoped to involve scraping or dredging the top 6 to 12 inches of soil on about 3 acres.

The groundwater beneath the BROS Site has demonstrated contamination which seems to be attributable to the lagoon. This groundwater contamination is migrating from the site, although at a slow rate, and has contaminated several residential wells in the immediate vicinity of the site with volatile organics at levels that exceed Federal and State drinking water criteria. For these reasons, this contaminated groundwater and the residential wells that it has (or may) affected will be considered for remediation.

Surface water and sediment in the vicinity of the BROS Site have not demonstrated substantial contamination, with the exception of the aforementioned area of visible oil contamination adjacent to the east-northeast side of the lagoon. Since this oil-contaminated area is to be included with lagoon cleanup options, no other local surface waters or sediments are determined to require consideration for remedial action at this time.

Data from the NUS Remedial Investigation show that hazardous wastes do remain in some of the tanks at the BROS Site, and that the integrity of these tanks is questionable. For these reasons, the tanks at the BROS Site are worthy of consideration for remedial action. Implicit in the evaluation of remedial actions for the tanks is the demolition and removal of unused buildings at the site.

Another aspect of the BROS Site that is worthy of consideration is the possibility that drums may be buried at the site. Consideration will be given to the possibility of excavating areas of suspected drum disposal (based on the data from the magnetometer survey) and disposing of any uncovered hazardous materials.

Section 4 of this report presents the preliminary identification of remedial technologies that address the previously discussed cleanup objectives. Also

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included in Section 4 is the initial screening of these technologies. Section 5 takes the technologies that passed the initial screening and develops them into remedial action alternatives. The developed alternatives are then evaluated and the most cost-effective alternative for the remediation of the BROS Site is selected.

## 4.0 PRELIMINARY REMEDIAL ALTERNATIVES EVALUATION

This section presents a preliminary identification of remedial action alternatives that may be applicable for cleanup of the Bridgeport Rental and Oil Services (BROS) Site. These alternatives were based upon data developed in a site Remedial Investigation conducted during the summer and fall of 1983 as well as site investigations performed by Camp Dresser and McKee (CDM) prior to 1983. Candidate remedial alternatives were identified early in the project so that the site investigations by NUS could be tailored to provide the necessary information regarding the feasibility of these alternatives. This information provides a basis for the development of detailed alternatives which are environmentally implementable and cost-effective.

### 4.1 Development and Screening of Remedial Action Technologies

#### 4.1.1 Background

The NCP outlines a three-phased process for the selection of the most appropriate remedial approach for a given site. First, a limited number of remedial action alternatives are identified and developed. Second, an initial screening of feasible technologies is required to reduce the number of alternatives to a workable number by eliminating obviously infeasible, inappropriate, or environmentally unacceptable alternatives. The third phase of remedial action selection involves a detailed analysis of a limited number of remedial alternatives based on technologies that have passed the initial screening stage. This process is required as outlined in Section 300.68 (g), (h), and (i) of the NCP which states:

- (g) Development of Alternatives. A limited number of alternatives should be developed for either source control or offsite remedial actions (or both) depending upon the type of response that has been identified as being appropriate.

(h) Initial Screening of Alternatives. The alternatives developed will be subjected to an initial screening to narrow the list of potential remedial actions for further detailed analysis.

(i) Detailed Analysis of Alternatives. (1) A more detailed evaluation will be conducted of the limited number of alternatives that remain after the initial screening.

Further, the NCP contains three requirements for any corrective action implemented at uncontrolled waste sites. (300.68 (h) (2)):

- The corrective action should not cause a significant adverse environmental impact.
- The action should provide adequate control to keep chemicals on site and prevent offsite migration of chemicals at levels which may have a detrimental or adverse effect.
- The action should mitigate or minimize any threat of harm to public health, welfare, or the environment.

To meet these requirements, the EPA also requires consideration of the following factors as stated in the NCP (300.68 (e) (3)):

- (i) The extent to which chemicals are a danger to public health, welfare, or the environment.
- (ii) The extent of chemical migration.
- (iii) Previous experience in similar situations.
- (iv) Environmental effects and welfare concerns.

The NCP (300.68 (j)) further states that a corrective action supported by "Superfund" shall be the lowest cost alternative that is technologically feasible and reliable.

In addition to the above, it is necessary that at least one alternative fully comply with the technical requirements of other environmental programs.

The full compliance alternative must be included in the detailed evaluation of alternatives and should not be eliminated in the initial screening step. The full-compliance alternative should be compared with the other alternatives that are developed with respect to the requirements of CERCLA (e.g. cost-effective protection of public health, welfare, and the environment). Both cost and effectiveness measures must be evaluated to determine if the full compliance alternative will be recommended.

Specifically, alternatives must be developed to comply with regulations for surface impoundments, waste piles, land treatment, or landfills, as appropriate. The most likely requirements that would apply for onsite alternatives are the technical regulations of the Resource Conservation Recovery Act (RCRA) (40 CFR Parts 264 and 265). Other environmental requirements that must be taken into consideration in the remedial action evaluation process for the BROS Site include:

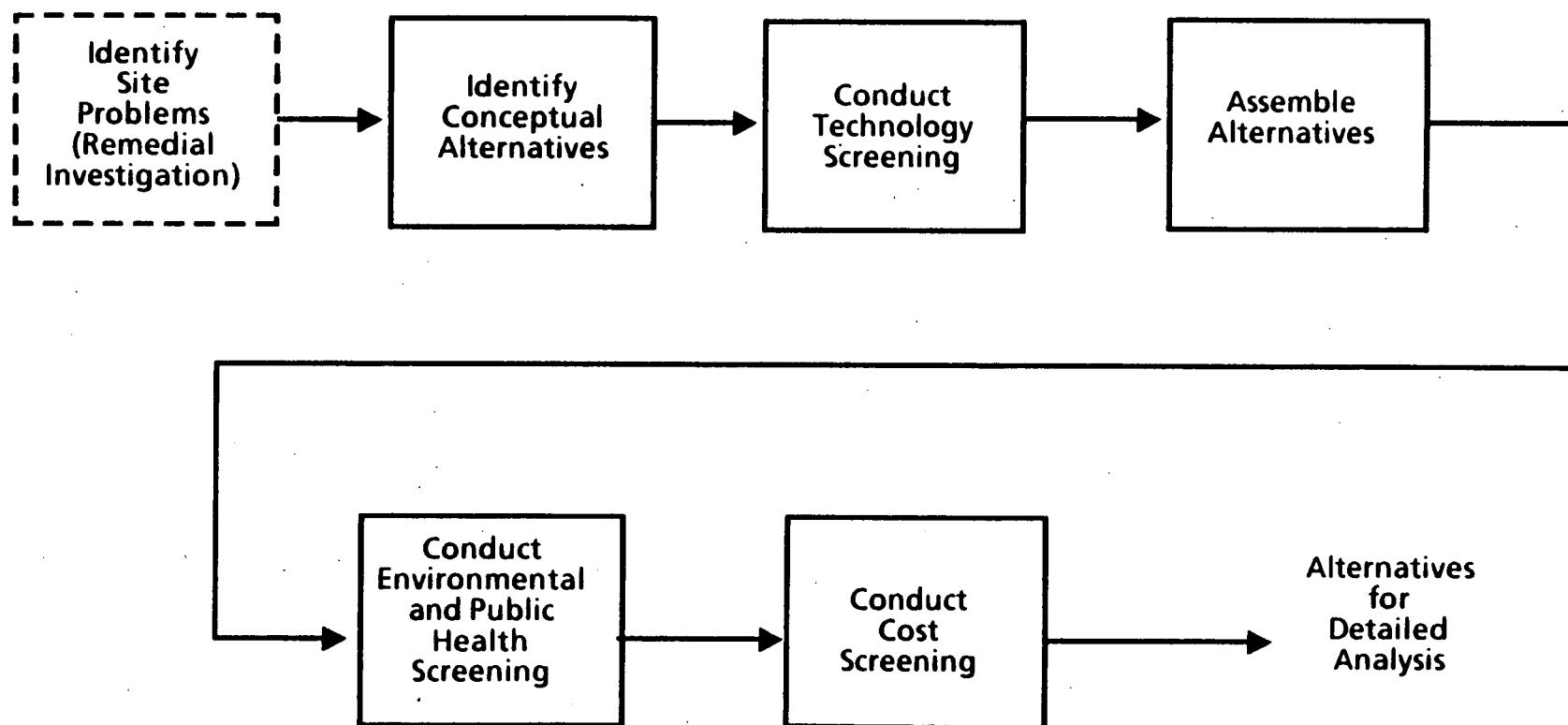
- Toxic Substances Control Act (TSCA), 40 CFR Part 761, for PCB wastes
- Executive Order 11988, Floodplain Management for sites located in floodplains
- Clean Air Act

#### 4.1.2 Overall Approach

A flow chart of the screening and alternative development procedure typically followed is shown in Figure 4-1 and consists functionally of the steps shown in the following:

- Identify problems and pathways of contamination (Remedial Investigation).
- Identify conceptual alternatives which address site problems and meet cleanup goals and objectives.
- Screen technologies comprising each conceptual alternative to eliminate inapplicable and infeasible technologies.
- Assemble alternatives based on the remaining feasible technologies and technology options.
- Screen alternatives in terms of environmental and public health impacts/benefits and eliminate those that pose significant adverse impacts or obviously do not adequately protect the environment, public health, and public welfare.
- Estimate order of magnitude costs and screen expensive alternatives that offer the same or lesser environmental and public health benefits.

The development and initial screening of remedial alternatives is actually an iterative process that may take place at several points in the remedial action evaluation process. The development and screening of alternatives may begin during the Remedial Investigation to better define field data collection requirements related to specific remedial actions. As more site data are developed, existing alternatives may be screened and additional alternatives developed to reflect the improved understanding of site conditions. Screening may



**Figure 4-1 Feasibility Study Alternative Development and Screening Process**

also occur during detailed analysis of alternatives if it is determined that an alternative is clearly inferior and should not be considered, or if an additional alternative is developed which is potentially the most cost-effective remedial action.

The alternative development and screening, as discussed in this section, represent a process that is generally done on an informal basis, usually described as "best engineering judgment." A formal procedure is not necessary at this point in the decision-making process.

Remedial actions at hazardous waste disposal sites include a wide spectrum of options to manage the wastes and the potential or actual contamination of groundwater, surface water, soils, and air. Previous remedial action experience has demonstrated the site-specific nature of the various options. No two sites are alike in their waste types and quantities, or in their hydrologic environment. The selected remedial action strategies must reflect the existing site-specific constraints.

Basic information is collected to evaluate potential remedial action strategies. This information includes:

- A characterization of the hydrogeologic conditions at the site, including soil types, groundwater flow patterns and quality, surface water quality, and climatic conditions.
- Knowledge of the waste characteristics, including waste types, compositions, quantities, and past handling practices.
- Understanding of potential and actual environmental impacts associated with the waste site, and evaluation of the potential impacts of remedial actions.

- Identification of the various remedial action technologies and an assessment of their technical feasibility and cost effectiveness at the particular site.

The wide spectrum of remedial action alternatives considered is listed in the following section. Some of these alternatives were eliminated as a result of the analysis and screening procedure that follows. At the end of the preliminary analysis, only those alternatives most feasible are recommended for detailed evaluation.

#### **4.2 Identification of Remedial Action Technologies**

This subsection outlines the types of remedial action technologies that are available and identifies potential strategies for implementing remedial action at the BROS Site. For reference, a listing of general response actions and associated remedial technologies is presented in Table 4-1.

For the purpose of this evaluation for the BROS Site, two distinct sources of potential contamination were defined (the tank farm area and the 12.7-acre lagoon), and several potential receptors were identified (including the residential wells contiguous to the site and the swamps and surface waters adjacent to the site). Given this approach, a list of potential strategies for the BROS Site was compiled and is presented in Table 4-2.

After the potential technologies applicable to the remediation of the BROS Site were identified, they were reviewed by representatives of NUS, the EPA Region II, and the Army Corps of Engineers at a technology review meeting. The identified technologies were evaluated with respect to achieving the site-specific objectives for remediation of the BROS Site based on the following criteria:

- Technical feasibility
- Cost effectiveness

TABLE 4-1

**GENERAL RESPONSE ACTIONS AND ASSOCIATED  
REMEDIAL TECHNOLOGIES**

No Action	- May include some monitoring and analyses
Containment	- Capping, dust control, addition of freeboard, groundwater containment barrier walls, bulkheads, gas barriers
Pumping	- Groundwater pumping, liquid removal, dredging
Collection	- Sedimentation basins, French drains, gas vents, gas collection systems
Diversion	- Grading; dikes and berms; stream diversion ditches and trenches; terraces and benches; chutes and downpipes; levees; seepage basins
Complete Removal	- Tanks, drums, soils, sediments, liquid wastes, contaminated structures, sewers and water pipes
Partial Removal	- Tanks, drums, soils, sediments, liquid wastes
Onsite Treatment	- Incineration; solidification; biological, chemical, and physical treatment
Offsite Treatment	- Incineration; biological, chemical, and physical treatment
In-situ Treatment	- Permeable treatment beds; bioreclamation, soil flushing; neutralization; land farming
Storage	- Temporary storage structures
Offsite Disposal	- Landfills; surface impoundments; land application
Alternative Water	- Bottled water; cisterns; above-ground tanks; deeper or upgradient supply wells; municipal water system; relocation of intake structure; individual treatment devices
Relocation	- Relocation of residents, businesses, and habitat areas

TABLE 4-2

POTENTIAL REMEDIAL ACTION STRATEGIES  
AT THE BROS SITE

Lagoon

- No Action
- Site Management (lagoon-level control)
- Cap System
- Waste Stabilization with Onsite Storage
- Onsite Encapsulation
- Onsite Incineration
- Wastewater Treatment
- In-situ Biodegradation of Waste
- Waste Removal with offsite disposal at an Annex I Incinerator
- Waste Stabilization with offsite disposal in an Annex II Chemical Landfill

Tank Farm

- No Action
- Tank Cleaning and Waste Removal
- Tank Demolition and Removal

Residential Wells

- No Action
- Carbon Filtration of Individual Residential Water Supplies
- Alternate Water Supply (pipeline from an existing municipal water system)

Groundwater

- No Action
- Passive Groundwater Controls (Flow Diversion)
- Active Groundwater Controls (Flow Manipulation)

- Implementation time frame
- Environmental effectiveness

Institutional/regulatory factors and safety considerations that might affect the implementability of an alternative were also considered. This information was then used to identify and screen potential remedial action strategies for the BROS Site.

The results of this comprehensive evaluation process are presented in the following section.

#### **4.3 Initial Screening of Remedial Action Alternatives**

##### **4.3.1 Lagoon**

During the evaluation of remedial action options for the 12.7 acre lagoon, a principal consideration was whether contaminated materials would remain in contact with the groundwater after completion of the particular activity. In the initial screening of lagoon alternatives, those alternatives that, when completed, permitted the hazardous waste in the lagoon (including the oil, aqueous, and contaminated sediment phases) to remain in contact with the groundwater were eliminated from further consideration. These alternatives were eliminated based on the fact that the wastes would continue to contaminate the groundwater. Further, the site would not be in compliance with the National Oil and Hazardous Substances Contingency Plan, 40 CFR Part 300. Also, the lagoon would be in the 100-year flood plain (i.e., 9.8 feet mean sea level (MSL) versus site average grade level of approximately 10 feet MSL). Additionally, under RCRA the lagoon would not comply with the requirements for the location of hazardous waste facilities in a manner to protect human health and the environment. Location of hazardous wastes within the aquifer of concern is unacceptable.

- No Action

#### General Description

Under the no-action alternative, the lagoon would remain in its present condition. Only periodic monitoring of groundwater and surface water contamination, and visual observations of the lagoon above grade dike wall integrity would be performed. The present treatment plant used to control the aqueous inventory would not be present.

#### Application at the BROS Site

This option is unacceptable for several reasons. First, without controlling the lagoon inventory, the possibility of dike breaching and/or overtopping could result in widespread environmental damage to the surface soils and surface water bodies contiguous to the site, as well as substantial damage to the Little Timber Creek watershed. Furthermore, such a release resulting from dike failure or overtopping would pose a risk to the health and welfare of the general public. Additionally, under the no-action alternative, the lagoon wastes would remain in contact with the groundwater, a situation which is unacceptable, as previously mentioned.

- Site Management

#### General Description

For the purpose of this evaluation, site management was considered to include the minimum effort to decrease the risk of breaching and/or overtopping of the lagoon as well as periodic maintenance and chemical monitoring. Since the Army Corps of Engineers has a contractor at the site pumping water out of the lagoon and treating it for discharge to Little Timber Creek, this option is feasible with respect to lagoon

inventory control. However, such a system would have to operate ad infinitum to be effective.

#### Application at the BROS Site

Although treating and discharging the lagoon aqueous phase is technically feasible, this alternative was screened from further consideration as an overall lagoon remediation alternative because the hazardous substances within the lagoon would remain in contact with and would continue to contaminate the groundwater.

- Cap System

#### General Description

Under this alternative, a cap system would be designed to reduce the amount of rainwater infiltration through the contaminated areas of the BROS Site, and thereby reduce the potential for subsequent leachate generation and groundwater contamination. The reduction of infiltration can be achieved through "capping" with impervious materials or surface sealing techniques. Many methods exist for capping. These can be generally grouped into the following classes:

- Synthetic membrane
- Low permeability soils
- Asphalt or concrete
- Multilayered cover system

#### Application at the BROS Site

Infiltration controls, such as synthetic membranes, clay caps, or multilayered covers, would be a medium-cost, relatively short time frame installation alternative at the BROS Site. However, a cap system, in and

of itself, cannot be considered a viable option to remediate site contamination problems. Instead it must be considered as an integral part of other lagoon remedial actions, such as waste excavation. Regardless of the lagoon cleanup option finally selected, a capping system may be considered to reduce possible groundwater contamination resulting from precipitation.

- Waste Stabilization with Onsite Storage

#### **In-Situ**

##### **General Description**

The liquid contents of the lagoon would be removed to the depth of the water table. Chemicals and inert materials such as soil, sand, or fly ash would be mixed with the contaminated lagoon sediment to form an admixture with the structural integrity and chemical characteristics necessary to meet RCRA delisting requirements.

##### **Application at the BROS Site**

Although the in-situ waste stabilization technique has been used successfully at some hazardous waste facilities, it would not be acceptable at the BROS Site. A major problem is that the hazardous materials in the lagoon would not be removed from contact with the groundwater. Also, the magnitude of physical effort to successfully blend the chemicals to produce a uniformly inert admixture capable of meeting delisting requirements would be impractical if not impossible. This option was, therefore, screened from further consideration.

**Lagoon waste excavation, stabilization, and replacement.****General Description**

For this stabilization alternative the same physical/chemical processes would be used to stabilize the waste as would be used for in-situ stabilization. However with this alternative, the waste would be removed from the lagoon, stabilized on shore in a stabilization facility (allowing the waste to be stabilized more uniformly and completely than would be possible with the in-situ case), and then returned to the lagoon. In order to satisfy RCRA requirements (i.e., storing the stabilized waste above the water table) the contaminated sediment would need to be excavated and stored above ground until the lagoon could be backfilled with clean material to an acceptable elevation above the water table.

**Application at the BROS Site**

Although in many cases, this alternative would pass the initial screening step, in this case it was eliminated from further consideration at the BROS Site on the basis of difficulty in implementation and based on the results from the leachability study (discussed in Appendix A). The available space at the BROS Site is not sufficient (even if the tanks are removed) to store the lagoon waste while the lagoon is being backfilled to above the water table (not to mention the area needed to set up the stabilization facility and to store the stabilizing agents). Additionally, this site would normally not be considered as a new storage facility for hazardous waste, based on the unfavorable site geological framework (e.g., sandy soils and high water table), and the fact that this facility would be located within the 100-year flood plain. Furthermore, as discussed in Appendix A, a leachability study was performed on one stabilization method. The results from this study showed that the stabilized sediment appeared to leach more organic contaminants than the unstabilized sediment. Therefore, this Feasibility Study cannot

demonstrate that a satisfactory stabilization method exists. With this alternative a significant reduction in the Hazard Ranking System value for this site would not be realized.

- Onsite Encapsulation

General Description

Under the encapsulation alternative, the lagoon wastes would be excavated and then reburied on site in an encapsulation cell. The component technologies associated with this alternative include:

- Cap system
- Liner system
- Site maintenance and monitoring

The cover and liner system would be designed to contain the wastes in a given area, isolating them from infiltration or groundwater inflow. The cover technologies for encapsulation are the same as those previously discussed for the cap system alternative. The difference lies in the "total isolation" approach of the encapsulation cell. In a secure cell, the cover system is tied into the liner system to create a total seal around the waste.

Side and bottom liners are necessary components of the encapsulation cell. The use of a passive liner system (no leachate collection) constructed of natural or synthetic materials of low permeability is a viable approach to minimizing groundwater inflow to the cell or leachate migration from the cell. A collection system could be included as a component of the liner to contain and collect seepage.

### Application at the BROS Site

The onsite encapsulation alternative was screened from further consideration at the BROS Site for much the same reasons as was the waste excavation, stabilization, and reburial alternative. Reiterating, the available area at the BROS Site is insufficient to allow for storage of the excavated lagoon waste while the lagoon pit is being backfilled to an acceptable level and an impermeable liner system is being constructed. Furthermore, the BROS Site is not believed to be a suitable location for a hazardous waste containment facility.

- Incineration

### General Description

High-temperature incineration offers an effective means of destroying PCBs and other organic contaminants. The organic contaminants present in the lagoon oil and sediment can be detoxified in an incinerator that complies with Federal and State regulations. The incineration could be performed either on site or at an offsite location. One of the advantages of onsite incineration of the lagoon waste materials is a reduction in transportation costs since only the residual ash from the incinerator needs to be hauled off site (the ash content of the lagoon waste ranges from about two percent for the oil up to about 70 percent for the sediment). Furthermore, high-temperature incineration is the technology required by the EPA for the disposal of materials containing greater than 500 ppm PCB. Appendix A addresses this disposal option in more detail.

### Application at the BROS Site

It would be necessary to obtain permits to incinerate waste at the BROS Site. The decision to give this alternative further detailed evaluation was based on the assumption that the intervening period between the selection

of a remedial action and the actual initiation of lagoon cleanup activities (e.g., incineration) will be about 2 years, which should be sufficient time to secure permission to incinerate the BROS lagoon wastes on site using an approved mobile incinerator. Furthermore, the cost savings that can be realized by incinerating wastes at the site are substantial in comparison with some offsite disposal options.

- Wastewater Treatment

General Description

Numerous wastewater treatment/disposal options are available for application to site-specific problems. Wastewater treatment technologies are well established, and have a high degree of confidence. There are basically three major functions of groundwater/wastewater treatment operations:

- Destruction
- Volume reduction
- Stabilization

Destruction techniques attempt to detoxify wastewater using chemical, physical, or thermal processes. Volume reduction techniques are designed to reduce the quantity of wastewater to be disposed. Using volume reduction, wastewater toxicity is not eliminated, but it becomes more concentrated. Stabilization processes are usually chemical techniques designed to stabilize the wastewater for disposal.

Application at the BROS Site

Possible applications for wastewater treatment at the BROS Site include the treatment of the contaminated lagoon water and the treatment of any extracted groundwater. Since wastewater treatment technologies are

well established and effective in reducing contaminant levels in water, and since the water treatment facility that is presently on site has demonstrated effective treatment of the lagoon water, this technology has passed the initial screening phase. However, this technology would need to be combined with other remedial actions to form an overall effective action since this technology does not address the lagoon oil or sediment. In the subsequent detailed evaluation of alternatives, both onsite water treatment (i.e., a system similar to EMPAK's facility that is currently at the site) and offsite water treatment (i.e., hauling water to an industrial wastewater treatment facility) will be considered.

- In-Situ Biodegradation of Waste

- General Description

Biodegradation of waste as an alternative involves the employment of a mutant strain of bacteria to metabolize and thereby destroy or detoxify the organic contaminants. This method of remediation has been found to be effective for oil spills, lagoon cleanups, and other hazardous waste applications. For effective microbial activity to occur, the proper strain of bacteria must be selected, an adequate and balanced supply of nutrients must be available (generally the oily waste with added nitrogen and/or phosphorus), and the system to be biodegraded must be aerated. Biodegradation in the chemical environment of the BROS lagoon would take several years before significant reduction in contamination occurs.

- Application at the BROS Site

Biodegradation of wastes in the BROS lagoon was eliminated from further consideration as a remedial action. Current research indicates that no specific microorganism has been discovered that will effectively oxidize or degrade highly chlorinated biphenyls, which are the contaminant of primary concern in the BROS lagoon (conversation with Albert Klee, EPA

Research Labs, Cincinnati, Ohio, March 1984). Reinforcing this research is a study conducted by CDM on the bio-oxidation of the BROS lagoon wastes. CDM reported in their study that rates of bio-oxidation of the lagoon wastes were very slow and evidence of bacterial acclimation to the wastes was not observed. Furthermore, the aeration that would be required for biodegradation could disturb the semi-impermeable layer of oil, sediments, and sludge that is believed to exist at the bottom of the lagoon. If this semi-impermeable layer is physically disturbed, then increased percolation of the lagoon contents into the groundwater is likely to occur.

- Waste Removal with Offsite Disposal at an Approved Incinerator

#### General Description

Under this alternative the lagoon oil and/or the lagoon sediment would be removed from the lagoon and hauled offsite to an approved PCB-incinerator. Appendix A of this report discusses this alternative in more detail.

#### Application at the BROS Site

Removal of lagoon waste and transporting it to an approved, offsite incineration facility is a well-established and commonly used action. Furthermore, incineration is the disposal method required by the EPA for the disposal of PCB-contaminated materials. Therefore, this alternative passed the initial screening phase for the BROS Site.

- **Waste Stabilization with Offsite Disposal in an Approved Chemical Waste Landfill**

#### General Description

This technology involves removing the lagoon oil and/or sediment from the lagoon and mixing it with chemicals and inert materials to form an admixture that contains no free liquids and has a load-bearing capacity of at least 150 pounds per square foot. (These requirements were identified in a conversation with Dean Cattieu of CECOS International, Inc.). The stabilized material would then be hauled off site to an approved chemical waste landfill for disposal. This alternative is discussed in greater detail in Appendix A.

#### Application at the BROS Site

As discussed in Appendix A, it is unacceptable to stabilize a nonsolid material containing greater than 500 ppm PCB into a solid material for the purpose of landfilling the waste. Therefore, on this basis, stabilization of the oil and/or sediment may not be permitted depending on the final ruling as to whether these wastes contain greater than 500 ppm PCB. Since the oil has consistently shown PCB levels above 500 ppm, stabilization of the oil phase has been removed from further consideration. However, the sludge has shown substantial variability in its PCB contamination, especially for the Treatability Study analyses presented in Appendix A. Therefore, stabilization of the sludge with offsite landfilling of the stabilized material has been retained for further consideration contingent upon the fact that the sediment, or at least part of it, will be classified as containing less than 500 ppm PCB.

#### 4.3.2 Tank Farm

During the conduct of the initial screening, it became clear that the ultimate resolution of the tank farm issue would be directly related to the remedial action selected for the lagoon. For all lagoon remedial actions, excluding no action and site management, the tank farm would have to be demolished and removed from the site to allow sufficient working area at the site to implement the lagoon remediation.

Nevertheless, to document the screening process as it applies only to the tank farm, the following presentation is made. For the sake of ease in analysis, it was assumed that any contract to perform tank farm remediation would be independent of any other site cleanup activities.

- No Action

##### General Description

Under the no action alternative, no effort would be initiated to either remove the tank wastes or to demolish and remove the tanks that are located in the onsite tank farm. The only activity under "no action" for the tank farm would be periodic monitoring to assess the physical integrity of the tanks and to observe if leakage of the tank contents is occurring.

##### Application to the BROS Site

The no-action alternative, with respect to the BROS tank farm, did not pass the initial screening phase because it is inconsistent with RCRA regulations. Under "closure" guidelines set forth in RCRA Part 265, all hazardous waste and hazardous waste residues must be removed from tanks and associated equipment.

Furthermore, if the tanks at the BROS Site are left untouched, it is likely that the hazardous contents of these tanks will eventually leak to the environment, resulting in contaminant migration and potential exposure of the general public to these hazardous wastes. In addition, the subsequent cleanup of the leaked waste will be more difficult and more expensive than if the tank wastes are removed before leakage occurs.

- Tank Cleaning and Waste Removal

General Description:

Under this remedial action, tank wastes would be removed from the tanks and properly disposed of, and the tanks would be thoroughly cleaned to remove any residuals. Following cleaning, the tanks would be sealed or patched to reduce the chance of rainwater accumulation. Also, access ladders would be removed and manways would be sealed to reduce the possibility of unauthorized entry into any of the tanks. Wastes removed from the tanks, along with any tank cleaning solutions, would be hauled off site to appropriate disposal facilities. Also included with the alternative would be the need to perform periodic inspections of the tank farm area to observe whether any tanks were accumulating rainwater or to identify any other potentially dangerous conditions that may be developing.

Application at the BROS Site

Without considering other site cleanup activities, this alternative passed the initial screening since the hazardous wastes in the tanks would be removed from the site; therefore, any threat to the environment, public health, and public welfare from these tank wastes would be eliminated.

- Tank Demolition and Removal

General Description:

With this option, the tank wastes would be removed and disposed, and the tanks would be demolished, removed from the site, and properly disposed. Also included under this action would be the demolition and removal of unused buildings at the site.

Application at the BROS Site

Since under this action, the wastes in the tanks would be removed from the site, and the tanks and buildings would be removed as well (thereby substantially decreasing the threat to the environment, public health, and public welfare), this alternative passed the initial screening. Additional advantages afforded by this alternative include the elimination of any need to conduct periodic inspections of the tank farm, an improvement in the aesthetic qualities of the site, and an increase in available space which may be necessary for other remedial actions at the site.

#### 4.3.3 Residential Wells

From the Remedial Investigation results and the results from the EPA residential well sampling program, it is apparent that domestic wells in the vicinity of the site are presently contaminated or may become contaminated. As indicated in the groundwater discussion in Section 3.2.2, ten domestic wells in the vicinity of the BROS Site have been contaminated or may reasonably be assumed to be in danger of contamination as a result of the conditions at the BROS Site. Therefore, any action with respect to the residential wells will be scoped on the basis of addressing the following wells: Keller (Van Scoy), Pepper Industries, Fish Diesel Repair, Byrnes, Lindle, Cahill, Newton, Fryberger, Hillman, and Bell. Since the Pepper Industries well is no longer used for domestic purposes, this well will not be included in the scoping of residential well actions. Wells other than the

aforementioned that have demonstrated contamination are not included in this action because they appear to have been contaminated by some source other than the BROS Site. These wells will be addressed through other efforts.

- No Action

General Description:

The no-action alternative, with respect to the residential wells, would involve doing only periodic water sampling and analysis at the domestic wells and possibly at some selected monitoring wells. The results from these analyses would be used to regularly evaluate whether a health risk to the well users was developing. If a health risk is identified, then some other action would be required.

Application at the BROS Site

The no-action alternative for the residential wells passed the initial screening on the basis that five of the ten wells have demonstrated no contamination, and three of the ten wells have shown low levels of volatile organic contamination that do not exceed accepted drinking water standards. Of the two remaining wells, the Pepper Industries well is not used, and the Keller well currently has a carbon filtration unit that appears to be performing adequately. For the BROS Site, the no-action alternative with respect to the residential wells will also include periodic changing of the carbon in the carbon filtration unit that has already been installed on the Keller well.

- Carbon Filtration of Individual Residential Wells

#### General Description

This residential well alternative would involve installing an activated carbon adsorption unit on each individual domestic well. Carbon adsorption is a well established and effective means of removing organic contaminants from drinking water. Also included with this alternative would be periodic monitoring of each residential well before and after the carbon filtration unit to assure that the carbon is not becoming exhausted, and to replace the carbon on a regular basis.

#### Application at the BROS Site

Providing carbon filtration units for each residential well passed the initial screening because it is a well-established technology and has been demonstrated to be effective in removing the contaminants specific to the groundwater in the vicinity of the BROS Site (as is evidenced by the results for the carbon filtration unit installed on the Keller well).

- Alternate Water Supply

#### General Description

Providing an alternate water supply to residents with contaminated wells is a well-established and common technology. This alternative involves extending a pipeline from a nearby municipal water system to the affected residents and thus replacing their contaminated water supply with a municipal water system hookup.

#### Application at the BROS Site

Providing an alternate water supply passed the initial screening for several reasons. This alternative effectively alleviates the contamination problem, does not require periodic monitoring at each home, and is technically feasible and implementable. The Pennsgrove Water Supply system is located nearby and would be capable of supplying water to the affected residents, based on the information presented in a study performed by CDM in January 1982.

#### **4.3.4 Groundwater**

Based on the Remedial Investigation results and the results from the residential well sampling, it is evident that the conditions at the BROS Site have caused contamination of the local groundwater. The alternatives presented in this section are the preliminary identified methods of reducing or eliminating the migration of contaminated groundwater from the site.

- No Action

##### General Description

Under the no-action alternative with respect to groundwater contamination, there would be no effort made to prevent the migration of contaminated groundwater or to clean up the contaminated groundwater. Long-term monitoring of the groundwater would be necessary under the no-action alternative.

##### Application at the BROS Site

Although the groundwater contamination, that is a result of conditions at the BROS Site, is threatening several residential wells in the vicinity of the site, the no-action alternative has been retained for further

consideration. Since it is possible that the evaluation of residential well alternatives will determine that a pipeline from a nearby municipal water system should be installed to service the affected or potentially affected residents, the existing groundwater contamination may no longer pose a threat to the public health. Therefore, no-action with respect to the contaminated groundwater may be appropriate.

- **Passive Groundwater Controls**

Various technologies are available to provide passive groundwater control of contaminant migration. Flow diversion is designed as a method to isolate the contaminated area so as to reduce groundwater migration from the site. The passive groundwater control that could be applicable to the BROS Site would be the use of cut-off walls.

#### **Cut-Off Walls**

##### **General Description**

A subsurface cut-off wall is designed to divert groundwater flow. The technique requires that an impermeable barrier extend below grade to intercept and cut off groundwater either entering or leaving a particular site. Typically, the impermeable barrier or cut-off wall would extend and key into the confining or semiconfining strata underlying the site. However, this is not always necessary, and, depending on the hydrogeologic conditions, partial cut-off walls can be an effective means of containing the migration of contaminants from a site.

The principal benefit of subsurface cut-off walls is the restricted potential for leachate migration in subsurface pathways where the primary mechanism of dispersion is groundwater flow. A second major benefit is that cut-off walls are normally constructed in an encompassing fashion; that is, not only do flow barriers restrict groundwater outflow

from a site, but they also restrict groundwater inflow to the site when constructed up-gradient from the site.

Depending upon the geologic conditions, the depth of penetration of a cut-off wall can vary from as little as several feet to in excess of 100 feet below ground surface. To a large extent, the depth of penetration will dictate the technique which is ultimately employed in the cut-off wall construction. Cut-off walls may be constructed using one of the following materials or methods:

- Compacted clay
- Synthetic membranes
- Slurry trench techniques using bentonite or other natural or synthetic materials
- Grout curtains
- Sheet piling
- Chemical injection
- Electro osmosis
- Ground freezing

#### Application at the BROS Site

Passive groundwater flow systems (cut-off walls) were eliminated from further consideration as potential remedial actions at the BROS Site for a number of reasons. First, the depth to the confining layer beneath the site (100 to 140 feet) approaches the limits of the feasible depth of cut-off walls; however, under ideal conditions, cut-off walls can be installed to this depth. Unfortunately, the conditions at the BROS Site are far from ideal for the construction of cut-off walls. The irregular site topography and the confined work space at the site would require that considerable site preparations be done and innovative construction methods be used in order to install cut-off walls. The presence of dikes around much of the BROS lagoon would preclude constructing cut-off

walls directly around the perimeter of the lagoon since the cut-off wall trench would seriously jeopardize the integrity and stability of these dikes. Instead, the cut-off wall would need to surround the Gaventa and Swindell Ponds, as well as the lagoon. If the cut-off wall must surround the lagoon and adjacent ponds, then additional problems develop. Since the Gaventa and Swindell Ponds are not on the BROS property, permission from the adjacent landowners would be required. Also, the presence of swamps around much of the site would pose considerable problems, including difficulty in maintaining trench stability during construction and difficulty in maintaining an adequate work base for construction equipment. Furthermore, if the cut-off wall would need to surround the Gaventa and Swindell Ponds, then the length of the wall would be substantially increased, thereby substantially increasing the cost of the wall.

Partial cut-off walls (walls that do not key into an underlying confining layer) were also considered. These walls, however, are only effective in containing contaminants which are immiscible with water and float on the groundwater surface. The types of contaminants detected at the BROS Site include chlorinated hydrocarbons, which tend to sink in water, as well as contaminants which are miscible in water. Furthermore, the construction difficulties previously mentioned for complete cut-off walls would also apply to partial cut-off walls. Another reason that cut-off walls were eliminated from consideration for the BROS Site is that cut-off wall by themselves do nothing to prevent lagoon overflows, nor would they prevent the spread of contaminated groundwater that has already migrated beyond the extent of the wall (unless the cut-off wall is constructed to encircle all identified contaminated groundwater; a scenario that would be extremely expensive and difficult to implement).

Based on the difficulty of installation, cost of construction, and limited effectiveness of this remedial action technology, subsurface cut-off walls have been eliminated from further consideration for the BROS Site.

- Active Groundwater Controls

General Description

Active groundwater control techniques rely upon the alteration or manipulation of groundwater flow patterns. Groundwater extraction was considered as the only viable flow manipulation technique that would be applicable at the BROS Site.

Groundwater extraction methods create a cone of depression in the zone of saturation. The intent of groundwater withdrawals is to lower the groundwater level, thereby reducing the hydraulic gradient and the flow through the contaminated area. When coupled with groundwater treatment, groundwater extraction can be used to remove and treat contaminated groundwater in order to renovate the aquifer. Active groundwater extraction techniques include the following technologies:

- French drains
- Collection sumps and pumps
- Deep or shallow extraction wells (large and small diameter)
- Collection galleries (well points)
- Vertical sand drains

Application at the BROS Site

In terms of using groundwater extraction to lower the water table to the level where it no longer contacts the lagoon waste, this alternative was eliminated from further screening. The aquifer characteristics are such that an enormous amount of water would need to be withdrawn in order to lower the static water table to below the lagoon bottom, and based on the discussion for passive groundwater controls, it would be very difficult to use cut-off walls in an attempt to reduce groundwater flow into the area that is trying to be dewatered. It is possible that once the lagoon level is

lowered to the water table, sheet piling could be installed inside the lagoon so that the water table could be lowered in a very localized area. However, in order for this scheme to work, the sheet piling (or other groundwater barrier) would need to be keyed into a confining layer and would need to allow very little leakage.

Based on the results from the groundwater modeling that was performed (see Section 3.2.2), it appears as though active groundwater controls, with the intent of renovating the contaminated aquifer, would be feasible for the BROS Site. Since plumes of contaminated groundwater are considered to be hazardous waste as defined by RCRA, a groundwater renovation scenario would be necessary to develop an overall alternative that provides complete cleanup of the site. Therefore, groundwater renovation will be retained for further consideration.

#### **4.4 Summary of Initial Screening Results**

Using the screening process previously discussed, the preliminary remedial technologies that were originally identified were reduced to a more workable number of technologies that are feasible and applicable to the BROS Site. In Section 5 of this report these technologies are evaluated in terms of this cost-effectiveness and are combined with other technologies in order to develop the most cost-effective remedial action for the BROS Site.

The following list presents the technologies that passed the initial screening phase. These technologies are categorized into groups according to which site problems the technology addresses (i.e., lagoon, tank farm, residential wells, groundwater). Furthermore, the lagoon technologies are further categorized into groups depending upon which phase of the lagoon cleanup the technology is involved (e.g., waste disposal, waste removal, site closure). The technologies that are determined to be the most cost-effective in each category will then be combined to form the overall cost-effective alternative for the BROS Site.

- Lagoon

Waste Disposal - Oil

- Onsite incineration
- Offsite incineration

Waste Disposal - Sediment

- Onsite incineration
- Offsite incineration
- Stabilize and landfill offsite (if less than 500 ppm PCB).

Waste Disposal - Aqueous Phase

- Onsite treatment
- Offsite treatment

Lagoon Waste Removal

- Remove oil (pump), remove aqueous phase (pump), dredge sediments (dragline, Sauerman Dredge).
- Remove aqueous phase (pump), dredge oil and sediment (dragline, Sauerman Dredge).

Closure

- Backfill lagoon to above the water table and revegetate with a provision for surface water runoff to discharge to Little Timber Creek.

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- **Regrade and revegetate lagoon sides, allow lagoon to remain as a pond (similar to the Swindell and Gaventa Ponds).**
- **Tank Farm**
  - **Tank cleaning and waste removal**
  - **Tank demolition and removal**
- **Residential Wells**
  - **No action/monitoring**
  - **Carbon filtration of individual wells**
  - **Alternate water supply (pipeline from Pennsgrove Water Supply Company)**
- **Groundwater**
  - **No Action**
  - **Active Groundwater Controls (Groundwater renovation by extraction and treatment)**

## **5.0 EVALUATION OF ALTERNATIVES**

### **5.1 Methodology for Evaluation of Alternatives**

After completion of the initial screening of technologies, a detailed evaluation of technologies was conducted in order to recommend a cost-effective alternative. The cost-effective alternative is the lowest cost alternative that is technologically feasible and reliable and that effectively mitigates or minimizes damage to and provides adequate protection of public health, welfare, and the environment (National Contingency Plan).

Each of the technology groupings identified in Section 4.4 was evaluated in terms of cost and effectiveness. The most cost-effective technologies from each of these categories were then combined to form the overall recommended remedial action for the BROS Site.

### **5.2 Criteria for Evaluation of Alternatives**

#### **5.2.1 Effectiveness Measures**

The critical components of effectiveness measures were selected to be technical feasibility as well as public health, institutional, and environmental effects. Particular emphasis was placed on the following:

- **Technical Feasibility**
  - Proven or experimental technology
  - Risk of failure
- **Public health effects**
  - Reduction of health and environmental impacts
  - Degree of cleanup

- Institutional effects
  - Legal requirements, institutional requirements
  - Community impacts
  - Approval of land use
- Environmental effects
  - Impact of failure
  - Length of time required for cleanup
  - Amount of environmental contamination with respect to acceptable levels

Based on these components, a set of independent "effectiveness measures" were synthesized, as follows:

- Technology Status
- Risk and Effect of Failure
- Level of Cleanup/Isolation Achievable
- Ability to Minimize Community Impacts
- Ability to Meet Relevant Public Health & Environmental Criteria
- Ability to Meet Legal, Regulatory, and Institutional Requirements
- Time Required to Achieve Cleanup/Isolation
- Acceptability of Land Use After Action

#### 5.2.1.1 Technology Status

Technologies involved in a remedial alternative are either proven, widely used, or experimental when applied to uncontrolled hazardous waste sites. Generally, a proven and widely used technology is to be rated highest, and experimental technologies lower. For some specific pollution problems, the only technology available for use at uncontrolled sites may be in the experimental stage. In such a case, an experimental technology may be chosen as cost-effective if it is highly rated with respect to the other effectiveness measures.

Special attention should be paid to whether experience in other less demanding situations is applicable to a remedial action situation.<sup>1</sup>

#### 5.2.1.2 Risk and Effect of Failure

The risk factor is the product of the probability of failure and the consequences of such a failure. A high risk is associated with high probability of failure and significant impacts. Alternatives with a low probability of failure and relatively minor potential impacts resulting from failure are considered low-risk alternatives.<sup>1</sup>

#### 5.2.1.3 Level of Cleanup/Isolation Achievable

In the context of this methodology, cleanup implies that contaminants are removed from the site and/or the environment by the remedial action alternative. Isolation means that the transport of contaminants from the site to the environment is stopped or slowed.<sup>1</sup>

#### 5.2.1.4 Ability to Minimize Community Impacts

A community impact is broadly defined as any change in the normal way of life which can be directly or indirectly attributed to the execution of the remedial action. These changes include those actions which people would not normally undertake, such as moving permanently from a condemned property, moving to temporary lodging during the remedial action, undergoing health monitoring, organizing citizens' groups to review the remedial action, seeking legal advice, and attending public meetings.<sup>1</sup>

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<sup>1</sup> This definition has been extracted from a methodology manual entitled Evaluating Cost-Effectiveness of Remedial Actions of Uncontrolled Hazardous Waste Sites produced by the Radian Corporation, Austin, Texas, in 1983.

The above impacts are in some cases merely a source of irritation to a community. However, some possible community impacts are clearly negative, such as increased noise during the action, traffic congestion, loss of access to the site or to roads near the site, decline in property values, and stress related to all of the above and to uncertainty about health risks.<sup>1</sup>

5.2.1.5 Ability to Meet Relevant Public Health and Environmental Criteria

This measure compares the remedial alternatives in terms of how well they attain relevant public health and environmental standards such as those under the Safe Drinking Water Act, Clean Water Act, or Clean Air Act. Alternatives would be compared on level of attainment rather than just attainment or non-attainment.<sup>1</sup>

5.2.1.6 Ability to Meet Legal, Regulatory, and Institutional Requirements

This measure assesses the requirements of a given remedial measure for local, State, and Federal permits, and the suitability of the measure to meet other pertinent legal requirements.<sup>1</sup>

5.2.1.7 Time Required to Achieve Cleanup/Isolation

The time required for a remedial action alternative to achieve its designed degree of cleanup or isolation may range from weeks to many years, depending on the technology and site conditions.<sup>1</sup>

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<sup>1</sup> This definition has been extracted from a methodology manual entitled Evaluating Cost-Effectiveness of Remedial Actions of Uncontrolled Hazardous Waste Sites produced by the Radian Corporation, Austin, Texas, in 1983.

#### 5.2.1.8 Acceptability of Land Use After Action

This measure assesses the potential for quality land use after completion of the remedial action.

#### 5.2.2 **Costs**

According to the National Contingency Plan, a total cost estimate for a remedial action must include both construction costs and annual operation and maintenance costs. The Total Construction Cost can be defined as the sum of the Total Direct Capital Cost and the Total Indirect Capital Cost (Radian Corporation, January 1983).

The following definitions have been extracted from a draft Superfund Feasibility Study Guidance Document compiled by JRB Associates, McLean, Virginia, 1983.

Direct capital costs may include the following cost components:

Construction Costs - Components include equipment, labor (including fringe benefits and workman's compensation), and materials required to install a remedial action.

Equipment Costs - In addition to the construction equipment cost component, remedial action and service equipment should be included.

Land and Site Development - Costs include land-related expenses associated with purchase of land and development of existing property.

Buildings and Services - Costs include process and non-process buildings and utility hook-ups.

Indirect Capital Costs may include the following components:

Engineering Expenses - Components will include administration, design, construction supervision, drafting, and testing of remedial action alternatives.

Legal Fees and License/Permit Costs - Components will include administrative and technical costs necessary to retain licenses and permits for facility installation and operation.

Relocation Expenses - Relocation expenses should include costs for temporary or permanent accommodations for affected nearby residents.

Start-up and Shake-down Costs - Costs incurred during remedial action start-up for long-term activities should be included.

Contingency Allowances - Contingency allowances should correlate with the reliability of estimated costs and experience with the remedial action technology.

The operation and maintenance cost may include the following components:

Operating labor costs - Include all wages, salaries, training, overhead, and fringe benefits associated with the labor needed for post-construction operations.

Maintenance materials and labor costs - Include the costs for labor, parts, and other materials required to perform routine maintenance of facilities and equipment for the remedial alternative.

Auxiliary materials and energy - Include such items as chemicals and electricity needed for treatment plant operations, water and sewer service, and fuel costs.

Purchased services - Include such items as sampling costs, laboratory fees, and professional services for which the need can be predicted.

Disposal costs - Costs should include transportation and disposal of any waste materials, such as treatment plant residues, generated during remedial operations.

Administrative costs - Cover all other O&M costs, including labor-related costs not included under that category.

Insurance, taxes, and licensing costs - Include such items as: liability and sudden and accidental insurance, real estate taxes on purchased land or right-of-way, licensing fees for certain technologies, and permit renewal and reporting costs.

Maintenance reserve and contingency funds - Represent annual payments into escrow funds to cover anticipated replacement or rebuilding of equipment and any large, unanticipated O&M costs, respectively.

Construction costs and operation and maintenance costs were estimated for the above criteria. For operating and maintenance costs, a "present-value" analysis was used to convert the annual costs to an equivalent single value. Operation and maintenance costs were considered over a 30-year period; a 10 percent discount rate and 0 percent inflation rate were assumed.

### 5.3 Evaluation of Alternatives

This section presents an examination and evaluation of the remaining alternatives with respect to cost and the effectiveness measures previously discussed. Each of the technologies that have passed the initial screening were grouped into categories depending on which site problem they addressed (i.e., lagoon, tanks, residential wells). The lagoon category was further subdivided into groups pertaining to various phases of the lagoon cleanup (i.e., waste disposal, waste removal, and site closure). Based on the evaluation that is to follow, the technologies that are selected to be the most cost-effective in each category will be combined to form the overall recommended remedial action with respect to the BROS Site.

### 5.3.1 Lagoon

As previously mentioned, each of the technologies that passed the initial screening for the remediation of the BROS lagoon were grouped into a category based on which aspect of the lagoon cleanup the technology addressed. Each of these categories (waste disposal--oil; waste disposal--sediment; waste disposal--water; waste removal; and site closure) will be evaluated separately, with the exception of waste removal, which is dependent on the selected disposal method, in order to determine the most cost-effective alternative in each category. The chosen technologies from each category will then be combined to form the overall cost-effective action with respect to the lagoon.

#### 5.3.1.1 Waste Disposal--Oil

The methods which have passed the initial screening for the disposal of the lagoon oil are:

- Onsite incineration
- Offsite incineration

#### General Description

Each of these oil disposal options is discussed in detail in Appendix A. In general, incineration of the oil can be performed either on site or at an offsite location. A brief description of each is presented below.

#### Onsite Incineration:

Onsite incineration of the lagoon oil would involve transporting and setting up a mobile incinerator on the site to incinerate the lagoon oil. Included with this technology would be the need to have laboratory facilities present at the site to assure compliance with all regulatory emission or discharge standards. Also included would be the need to properly dispose of the residual ash produced from

the incineration of the oil. At least one commercial firm (Pyrotech System, Inc.) has a mobile incinerator that is licensed under TSCA to incinerate PCB-contaminated materials. Pyrotech is also in the process of building several more mobile incinerators in the hope of having these incinerators licensed to incinerate PCB articles as well. The subsequent evaluations for the disposal of the oil will use information gathered with respect to the Pyrotech mobile incinerator.

A major requirement for onsite incineration would be to have the mobile incinerator licensed in the State of New Jersey to incinerate the specific waste at the site. The licensing procedure is believed to be similar to the procedure outlined by the TSCA for the licensing of PCB incinerators. It is expected that to secure the necessary permits, the mobile incinerator will have to undergo test burns with the specific waste to demonstrate satisfactory destruction of the toxic components of the waste. Assuming that successful test burns can be performed, this licensing procedure is can take between 6 months and 2 years to complete.

In order to operate an onsite incinerator at the BROS Site, at least the following permits are expected to be required:

- Air Pollution Control Permit
- Waste Management Hazardous Waste Incinerator Permit
- Federal PCB Disposal Permit

It is expected that air quality modeling will be required with respect to lead, arsenic, beryllium, cadmium, chromium, and nickel. The purpose of this modeling would be to demonstrate conformance with appropriate air quality standards to show that the concentrations of these metals in the ambient air would be at acceptable levels.

Offsite Incineration:

Offsite incineration of the lagoon oil would involve hauling the oil to a PCB-approved incinerator. The oil would then be incinerated and the residual ash would be disposed of as required by law.

Evaluation of Oil Disposal Options

Technology Status:

On the basis of technology status, both onsite and offsite incineration are roughly equivalent. Both technologies are approved by the EPA to handle PCB wastes, and both options use roughly the same incineration technologies. The only real difference is that the onsite incinerator is a smaller unit and is able to be moved from one site to another while the offsite incinerator must remain stationary. Because the onsite incinerator is smaller than the offsite incinerators, it incinerates waste at a slower rate.

Risk and Effect of Failure:

Since the technologies used for the onsite and offsite incineration options are virtually the same, the risk of failure for each option should also be roughly the same. The effect of failure in each case (i.e., incomplete combustion of the wastes with noxious discharges to the atmosphere) would also be roughly equivalent, depending on where the offsite incinerator is located. For example, a failure at the SCA incinerator near Chicago, Illinois, would possibly have a greater effect than a failure with an onsite incinerator, since the Bridgeport area has a low population density relative to Chicago. On the other hand, incineration of the oil at sea (At-Sea-Incineration, Inc.) would have less of an effect in the event of a failure than onsite incineration. Each of the incineration technologies is roughly equivalent in terms of risk and effect of failure.

One area in which onsite incineration would pose less of a risk than offsite incineration would be transportation. In the onsite incineration case, only the residual ash (about 2 percent by weight of the oil) would need to be hauled over the road. However, for offsite incineration, all of the oil would need to be transported rather than just the residual ash. Furthermore, the raw oil is considered to be more toxic than the residual ash in the event of a spill during hauling. When one considers the transportation risk, the onsite incineration option poses less of a risk than offsite incineration.

Level of Cleanup/Isolation Achievable:

The level of cleanup/isolation achievable under onsite incineration and offsite incineration is equivalent since both options use the same method to destroy the contaminants in the oil, and in both cases the oil no longer remains at the site.

Ability to Minimize Community Impacts:

With respect to the actual site work interfering with the everyday activities of the general public, onsite incineration would be favored over offsite incineration because offsite incineration would require that substantially more trucks enter and leave the site for the hauling of the oil. Fortunately, the site is located very close to the entrance of a major highway; therefore, hauling vehicles would not need to travel very far through the local community.

One area in which onsite incineration may be more unfavorable than offsite incineration is with respect to public sentiments. It is possible that the local community will consider onsite incineration unfavorably and will strongly favor offsite incineration instead.

**Ability to Meet Relevant Public Health and Environmental Criteria:**

Onsite and offsite incineration are roughly equivalent in their ability to meet public health and environmental criteria since each option uses the same basic technology.

**Ability to Meet Legal, Regulatory, and Institutional Requirements:**

Offsite incineration would be rated more favorably than onsite incineration in terms of legal and institutional requirements since the offsite incinerator to be used would already be permitted to incinerate PCB wastes. Onsite incineration, on the other hand, would need to be permitted to operate in the State of New Jersey even though it is already permitted under TSCA for another area. Depending on the sentiments of the State and the results from any test burns for the onsite incinerator, the time to obtain the necessary permits could take 6 months or more. Since the time period between the selection of an alternative and the initiation of lagoon waste disposal activities is expected to be about 2 years, it is possible that the onsite incinerator could be permitted without delaying site activities.

**Time Required to Achieve Cleanup/Isolation:**

The time required to incinerate the lagoon oil on site (2 to 3 million gallons) is expected to take between 150 and 250 days. This estimate is based on continuous operation, assuming 10,000 BTU/pound of oil and a throughput rate (supplied by Pryotech) of 40 million BTU/hour for the onsite incinerator. Permit acquisition time, start-up and shut-down time, and any downtime for unit maintenance are not included in the time estimate for onsite incineration of the lagoon oil.

The time required to incinerate the lagoon oil offsite could be somewhat less than onsite incineration since the stationary, offsite incinerators generally have a higher throughput rate. However, difficulties in scheduling offsite incinerators to treat the oil may significantly influence how rapidly the oil can be hauled from the site.

The time required for onsite incineration could be decreased by using two or more mobile incinerators, although it is unlikely that two or more mobile incinerators would be used at the BROS Site. Offsite incineration could be accelerated by sending the oil to a several different incineration facilities.

Acceptability of Land Use After Action:

Neither disposal option affects land use after the action.

Costs:

The costs for onsite and offsite incineration are discussed and developed in detail in Appendix A. The costs include incineration costs, hauling costs, and ash disposal costs. Mobilization and permitting costs are also included for the onsite incineration case; however, these costs are relatively insignificant with respect to the overall disposal cost. Onsite incineration assumes that the Pyrotech mobile incinerator or an equivalent incinerator will be used, and the residual ash (about 2 percent by weight of the oil) will be disposed of at the CECOS chemical waste landfill in Niagara Falls, New York. Offsite incineration assumes that the oil will be incinerated at ENSCO in El Dorado, Arkansas or SCA in Chicago, Illinois, since the costs are about the same for each of these offsite incineration options. The costs presented below do not include removal of the oil from the lagoon.

The low and high estimates for the quantity of lagoon oil were developed based on visual observations of the thickness of the floating oil layer during Remedial Investigations activated and on estimates developed in previous reports. The 2 million gallon estimate assumes an oil thickness of about 6 inches spread uniformly over 12.7 acres; the 3 million gallon estimate assumes an oil thickness of about 9 inches spread uniformly over 12.7 acres.

<u>Method</u>	<u>Cost (Millions of Dollars)</u>	
	<u>2 X 10<sup>6</sup> gal</u>	<u>3 X 10<sup>6</sup> gal</u>
Onsite incineration - oil	2.12	3.18
Offsite incineration - oil	6.92	10.4

#### Recommendation for Oil Disposal:

From the previous discussion, onsite incineration and offsite incineration are relatively equivalent in terms of technology status, level of isolation/cleanup achievable, ability to meet public health and environmental criteria, and acceptability of land use after the action. Onsite incineration was slightly favored in risk and effect of failure, while offsite incineration was significantly favored in ability to minimize community impacts and ability to meet legal, regulatory, and institutional requirements. In addition, offsite incineration would result in faster disposal of the oil.

In terms of cost, offsite incineration is estimated to be about 3 times more expensive than onsite incineration, with the potential savings to the government being from 4 to 7 million dollars if onsite incineration is used.

Based on cost factors, onsite incineration is recommended for the incineration of the lagoon oil. Onsite incineration can offer substantial savings over offsite incineration without compromising safety or the level of cleanup/isolation achievable. Although onsite incineration was less favorable than offsite incineration in terms of public acceptance and permitting requirements, it is felt that each of these potential problems can be resolved, in which case onsite incineration can be used at the site.

It must be noted that although onsite incineration is recommended based on the evaluation presented in this Feasibility Study, the actual method of lagoon oil disposal will be determined during the design phase and will take into account the

open market at the time lagoon cleanup activities begin. For example, a chemical waste incinerator (which is currently not approved to handle materials containing greater than 50 ppm PCB) is located within 5 miles of the BROS Site. If this nearby offsite incinerator is approved to incinerate PCB-contaminated materials, then it is possible that the cost to incinerate the lagoon oil at this offsite incinerator could be competitive with the cost for onsite incineration. Therefore, it is possible that offsite incineration of the lagoon oil could be a viable, cost-effective option, even though this study shows that onsite incineration is the most cost-effective alternative at this time.

#### 5.3.1.2 Waste Disposal--Sediment

The methods that have passed the initial screening for the disposal of the lagoon sediment are as follows:

- Onsite incineration
- Offsite incineration
- Stabilization and Landfilling

#### General Description

Each of the sediment disposal options is discussed in greater detail in Appendix A. A brief description of each option is presented below:

##### Onsite Incineration:

This technology is essentially the same as for lagoon oil disposal since the same mobile incinerator could incinerate both the oil and the sediment. The only major difference is that substantially more ash will be generated for sediment incineration since the sediment contains up to 70 percent ash, whereas the oil contains only about 2 percent ash, based on analyses performed during the Treatability Study. The results of these analyses are presented in Tables A-2 and A-3 in Appendix A.

**Offsite Incineration:**

Offsite incineration of the lagoon sediment is also virtually the same as for the lagoon oil. All of the same incineration facilities applicable to the oil could also incinerate the sediment, with the one exception of At-Sea-Incineration, Inc., which cannot accept wastes with high solids content.

**Stabilization and Landfilling:**

Under this disposal option, the lagoon sediment would be removed from the lagoon, stabilized on site in a stabilization facility, and hauled to an approved chemical waste landfill. This alternative can only be used if the sediment is categorized as containing less than 500 ppm PCB; otherwise the sediment would require incineration because it is a nonsolid at present, and nonsolids containing greater than 500 ppm PCB cannot be stabilized into solids for the purpose of landfilling. The only exception would be if the EPA Regional Administrator granted special permission. If the sediment is deemed to contain less than 500 ppm PCB, then it could be landfilled if it is stabilized so as to contain no free liquids and to have a load bearing capacity of 150 pounds per square foot.

**Evaluation of Sediment Disposal Options**

Since onsite incineration and offsite incineration compare similarly for disposal of the sediment as for disposal of the oil, it is assumed that onsite incineration would be recommended over offsite incineration for the sediment based on the same reasoning put forth in the oil disposal discussion. Consequently, in the following discussion for sediment disposal, waste stabilization and landfilling will be compared only to onsite incineration.

**Technology Status:**

The technology status of onsite incineration and stabilization and landfilling are roughly equivalent since both options are well established technologies and are

acceptable to the EPA, assuming that the sediment contains less than 500 ppm PCB.

#### Risk and Effect of Failure:

The risk associated with onsite incineration is believed to be less than for stabilization and landfilling. Since the State of New Jersey requires continuous stack monitoring, a failure in the onsite incineration process (i.e., incomplete combustion of toxic components) would be recognized almost immediately, and corrective action, such as unit shutdown or process modification, could be taken quickly. On the other hand, a failure in the stabilization and landfilling option (i.e., leaching of toxic chemicals from the waste and seepage from the landfill) could occur for a considerable length of time before being detected and could be difficult or impossible to remedy.

In terms of transportation, the risk and effect of failure in either disposal case would be similar, although slightly more risky for stabilization and landfilling since roughly twice as much material would need to be hauled (based on 70 percent ash content of the sediment and assuming a 25 percent volume increase caused by stabilization). The effect of failure (i.e., a spill during transportation) would be similar for onsite incineration and stabilization and landfilling because in each case the material being handled (ash vs. stabilized waste) would be a solid and would be relatively easy to clean up as compared to liquids. The exception would be if the material were spilled in such a way so as to be irretrievable (e.g., in a surface water body). In that case, the stabilized sediment could be more hazardous since it would still contain PCBs, whereas the incineration ash would not.

#### Level of Cleanup/Isolation Achievable:

The level of cleanup/isolation achievable under onsite incineration and stabilization and landfilling is the same, since in each case, the sediment would no longer remain on site. Overall, however, onsite incineration may be slightly favored because the hazardous organic constituents of the sediment would be destroyed, whereas for

stabilization and landfilling these hazardous constituents are only moved to a more secure environment.

**Ability to Minimize Community Impacts:**

With respect to the site work interfering with the everyday activities of the general public, onsite incineration would be favored over stabilization and landfilling because the stabilization and landfilling option would require that roughly twice as many hauling trucks enter and leave the site, as compared to onsite incineration. Fortunately, the site is located near the entrance of a major highway so only a small part of the local community would be affected by the increased truck traffic.

An area in which onsite incineration may be less favorable than stabilization and landfilling is with respect to public sentiments. The local public may not trust the effectiveness of onsite incineration, preferring that the waste be excavated and hauled away from their community.

**Ability to Meet Relevant Public Health and Environmental Criteria:**

Onsite incineration is slightly favored over stabilization and landfilling in its ability to meet public health and environmental criteria. This determination is based on the fact that the sediment must contain less than 500 ppm PCB to qualify for stabilization and landfilling. Because of the variability in the observed PCB levels in the sediment, the possibility exists that at least some sediment containing greater than 500 ppm PCB could be stabilized, a situation that would violate environmental regulations. On the other hand, onsite incineration can meet environmental criteria regardless of the PCB content of the sediment.

**Ability to Meet Legal and Institutional Requirements:**

Sediment stabilization and landfilling is slightly favored over onsite incineration because of the permits that would be required for the onsite incinerator.

Nevertheless, as previously stated in the oil disposal discussion, the expected time period between the selection of a remedial action and the initiation of lagoon cleanup activities (about 2 years) is believed to be sufficient to secure the necessary permits for onsite incineration. Also, there may be some difficulty in receiving permission to stabilize and landfill the sediment, and if this permission cannot be received, then stabilization and landfilling would not be implementable.

#### Time Required to Achieve Cleanup/Isolation:

The time required for incineration of the sediment on site is expected to be longer than the time required to stabilize and landfill the sediment. Incineration on site is expected to take from 100 to 250 days, based on continuous operation of the incinerator and assuming a heating value for the sediment of 1000 BTU/pound and a throughput rate for the incinerator of 40 million BTU/hour. Stabilization and landfilling, on the other hand, may take only 30 to 60 days, assuming that the stabilization process will operate continuously and can process about 50 cubic yards of sediment per hour. This estimate also assumes that the stabilization of the sediment is the slow step in the overall process. Permit acquisition time, start-up and shut-down time, and any down time for unit maintenance are not included in either of these time estimates. Both of these time estimates were developed based on the low and high sediment quantity estimates presented and explained in the "Costs" discussion. The onsite incineration process could be accelerated by using two or more mobile incinerators, although it is unlikely that more than one mobile incinerator would be used at the site.

#### Acceptability of Land Use After Action:

For both sediment disposal options, the sediment no longer remains at the site; therefore, the acceptability of land use after the action is the same in each case.

**Costs:**

The costs presented below are developed in greater detail in Appendix A. The cost for offsite incineration of the sediment is included for the purposes of comparison. The offsite incineration cost includes the incineration fee (at SCA in Chicago, Illinois, or ENSCO in El Dorado, Arkansas since the costs are about the same), transportation costs, and ash disposal costs. The onsite incineration cost estimate includes mobilization and permitting of the incinerator, incineration fee, and ash disposal cost (including transportation and ash disposal fee). For both offsite and onsite incineration, the ash is assumed to require disposal at an approved chemical waste landfill; substantial savings can be realized for both incineration options if the residual ash can be delisted and disposed of in a sanitary landfill or redispersed on site. The sediment stabilization and landfiling cost estimate includes the cost for equipment, materials, and labor to stabilize the sediment and the cost to haul the sediment to CECOS, Niagara Falls; the disposal costs listed below do not include removal of the sediment from the lagoon.

It should be noted that the cost estimate developed in this study for the onsite incineration of the sediment assumes that the lagoon oil and lagoon sediment will be removed from the lagoon simultaneously (but separately) and will be temporarily stored separately. By removing the lagoon waste in this fashion, the lagoon oil and lagoon sediment can be blended in a controlled manner to form the optimum feed for the incinerator. Because the oil has a high heating value and the sediment has a low heating value, if the oil and sediment can be mixed in the optimum proportions and incinerated together, then the amount of supplemental firing fuel needed for the incinerator can be minimized. If the sediment must be incinerated without being mixed with the oil, the onsite incineration cost for the sediment may increase.

The low sediment quantity of 40,000 cubic yards was developed based on the assumption that a 2-foot layer of sediment will be removed over the entire 12.7

acres of the lagoon. The high sediment quantity of 80,000 cubic yards was developed based on the removal of a 4-foot-thick layer of sediment over 12.7 acres.

<u>Disposal Method</u>	<u>Cost (Millions of Dollars)</u>	
	<u>40,000 yd<sup>3</sup></u>	<u>80,000 yd<sup>3</sup></u>
Onsite Incineration	21.6	43.2
Offsite Incineration	86.0	172.0
Stabilization and Landfilling	17.2	34.3

From the above costs, it seems apparent that stabilization and landfilling is the least expensive option, followed closely by onsite incineration. However, it should be noted that the stabilization and landfilling cost estimate assumes that all of the sediment will be allowed to be stabilized and landfilled. If, on the other hand, some of the sediment contains greater than 500 ppm PCB, then that portion would require incineration. Because of space limitations at the site (as well as the cost to keep the onsite incinerator inactive) it is felt that an onsite incinerator and a stabilization facility could not both be located on site at the same time. Therefore, if sediment stabilization and landfilling is the selected disposal option, then any sediment containing greater than 500 ppm PCB would need to be incinerated off site. Under this scenario, if between 5 and 10 percent of the sediment contains in excess of 500 ppm PCB, (and must therefore be offsite incinerated), then the cost for stabilization and landfilling will increase to about the same cost as onsite incineration. As the percent of sediment containing greater than 500 ppm PCB is increased, the cost for the stabilization and landfilling option likewise increases. (Based on the analytical results from sediment sampling, it is evident that substantially more than 5 percent of the lagoon sediment contains greater than 500 ppm PCB). On the other hand, the onsite incineration cost remains constant, regardless of the PCB content of the sediment. Furthermore, under the stabilization and landfilling option, a fast and reliable method of determining PCB concentrations in the sediment would need to be developed and approved.

**Recommendation for Sediment Disposal:**

Onsite incineration is selected over offsite incineration at the very beginning of the evaluation because onsite incineration was preferred over offsite incineration for the oil disposal case, and sediment disposal is very similar to oil disposal.

Comparing onsite incineration to the option of stabilization and landfilling in terms of effectiveness, both options were roughly equivalent in terms of technology status, level of cleanup/isolation achievable, and acceptability of land use after the action. Stabilization and landfilling was slightly favored over onsite incineration in terms of ability to meet legal and institutional requirements, time to achieve cleanup, and community impacts.

Onsite incineration, on the other hand, was slightly favored over stabilization and landfilling for its ability to meet public health and environmental criteria, and in terms of risk and effect of failure.

With respect to cost, stabilization and landfilling is less expensive than onsite or offsite incineration, assuming all of the sediment can be landfilled. However, if between 5 and 10 percent of the sediment contains greater than 500 ppm PCB, the cost for stabilization and landfilling plus the required offsite incineration would roughly equal the cost of onsite incineration. As the percentage of sediment containing more than 500 ppm PCB is increased, the cost for stabilization and landfilling quickly surpasses the cost for onsite incineration, and approaches the extremely expensive option of offsite incineration. Also, the cost for onsite incineration may be reduced if the residual ash from the incineration process can be delisted. As previously mentioned, this evaluation is based on the fact that onsite sediment incineration and onsite oil incineration can be coordinated so that the optimum feed to the incinerator can be achieved.

It is recommended that onsite incineration be used for the disposal of the lagoon sediment. Onsite incineration is effective for the sediment disposal and is potentially the least expensive option. Furthermore, since onsite incineration was

recommended for the disposal of the oil, community relations problems would have already been addressed. Also, if a permit can be obtained for onsite incineration of the oil, it is reasonable to expect that it will be obtainable for the sediment disposal. A cost savings, with respect to permit acquisition, may also be realized since the permitting for the oil incineration and the sediment incineration is expected to be coordinated. Furthermore, onsite incineration can be used regardless of the PCB content of the sediment, and monitoring of the PCB content in the sediment would not be as vigorous as for the stabilization and landfilling options. Also, if the oil and sediment should become mixed, stabilization may no longer be possible (either technically or legally), while onsite incineration would still be applicable.

As previously mentioned in the oil disposal discussion, it is important to note that although onsite incineration is recommended for lagoon sediment disposal, based on the evaluation presented in this study, the actual method of sediment disposal will be determined by the open market. A situation such as an incineration facility near the site being licensed to incinerate PCB wastes may result in the cost for offsite incineration of the sediment being comparable to onsite incineration. Therefore, even though onsite incineration is recommended by this Feasibility Study, the possibility that some or all of the lagoon waste may be incinerated at an offsite facility should not be eliminated from consideration.

#### 5.3.1.3 Waste Disposal--Water

Two options for the disposal of the BROS lagoon water passed the initial screening of alternatives. These water disposal options are:

- Onsite treatment
- Offsite treatment

### General Description

#### Onsite Treatment:

The onsite treatment option for the disposal of the BROS lagoon water involves the construction of a treatment facility on site (similar to the water treatment facility that is presently on site). The lagoon water would be pumped through this treatment facility and the treated water would be discharged to Little Timber Creek. Included in this option would be regular and frequent monitoring of the treatment plant effluent to monitor whether appropriate water quality criteria are being met. State and Federal discharge permits will be required.

The unit processes of the onsite treatment facility are expected to include an oil/water separator, a flocculation tank, a clarifier, multimedia filters, and granular activated carbon adsorption units. Mixing tanks for pH adjustment and chemical addition, as well as appropriate holding tanks, would also be included. The onsite treatment facility is expected to be different from the facility that is now at the site in that sludge dewatering beds and sludge handling facilities (for sludge that is generated by the treatment plant) would also be needed. The clarifier underflow from the treatment plant that is now at the site is returned to the lagoon; this practice would not be acceptable with respect to an overall cleanout of the lagoon. Under the onsite treatment alternative, sludge generated by the treatment facility would be dewatered and then incinerated in the onsite incinerator. If water treatment continues after the onsite incinerator is demobilized, then sludge that is subsequently generated would be incinerated offsite or landfilled at a chemical waste landfill, depending on the PCB content of the sludge.

#### Offsite Treatment:

This lagoon water disposal option involves pumping the lagoon water into tanker trucks and hauling it to a nearby industrial wastewater treatment facility. In the scoping of this option, the Dupont Chambers Works was assumed to be the

treatment facility that would be used for disposal of the water. The Dupont Chamber Works is located less than 20 miles from the BROS Site. This disposal option assumes that the lagoon water is acceptable for treatment at Dupont.

### Evaluation of Alternatives

#### Technology Status:

The technology status of the two water disposal options is roughly equivalent even though different unit processes may be used in either case (i.e., biological waste treatment and powdered activated carbon treatment at Dupont versus granular activated carbon adsorption for onsite treatment). The Dupont facility is currently operating on an industrial scale so the technology status is documented and accepted. The onsite treatment facility that is currently at the BROS Site is providing adequate treatment of the lagoon water; thus the technology status of onsite treatment is also demonstrated to be good.

#### Risk and Effect of Failure:

With respect to risk and effect of failure, offsite treatment and onsite treatment are considered to be about equal. On one hand, offsite treatment would pose a minimal risk since the lagoon water is expected to be taken to a treatment facility with the capacity to treat millions of gallons of wastewater per day, and the BROS lagoon water would only constitute a small fraction (less than one percent) of the total treatment stream. The onsite treatment system would be very small in comparison, and a small problem could result in inadequate water treatment. The effect of such a failure would be that contaminated water would be discharged to Little Timber Creek.

Balancing the aforementioned risk associated with onsite treatment is the fact that all of the lagoon water would need to be transported over-the-road for the offsite

treatment option. Therefore, the possibility of environmental contamination caused by spillage during transportation is a risk that must be considered for the offsite treatment option.

**Level of Cleanup/Isolation Achievable:**

The level of cleanup achievable with each of the water disposal options is roughly equal, assuming proper design and operation of the onsite facility and assuming that the water is acceptable to the offsite treatment plant.

**Ability to Minimize Community Impact:**

Community impacts are expected to be more favorable for onsite treatment than for offsite treatment because a substantial increase in truck traffic will occur in the vicinity of the site under the offsite treatment option. This increased truck traffic may disrupt the residents living near the site. Public opposition to an onsite water treatment facility is expected to be low based on the fact that a water treatment facility is now operating at the site and has apparently been well received by the local community.

**Ability to Meet Relevant Public Health and Environmental Criteria:**

Assuming proper design and operation of the onsite facility, and acceptability of the water at an offsite facility, each of the lagoon water treatment options should be equally capable of meeting relevant public health and environmental criteria.

**Ability to Meet Legal and Institutional Requirements:**

Offsite treatment of the water is slightly favored over onsite treatment of the water with respect to legal and institutional requirements since the offsite facility is presumably fully permitted and licensed. An onsite treatment facility would

require applicable State and Federal permits; however, since the existing water treatment facility at the site has been permitted, it is assumed that permitting of an onsite treatment plant at a later date should be possible.

**Time Required to Achieve Cleanup/Isolation:**

In general, the onsite treatment facility would be limited by its capacity flow rate, and offsite treatment would be limited by how quickly hauling vehicles could be brought to the site and how quickly they could be loaded. Nevertheless, it is expected that water treatment will be required throughout the cleanup activities, so, in this respect, both disposal options would be about equal in the length of time required to achieve cleanup.

**Acceptability of Land Use After Action:**

This evaluation criterion is not applicable to the water treatment options.

**Costs:**

Because of the uncertainty regarding the quantity of water that may require treatment, the costs were developed for the estimated least and greatest quantity of water that is expected to need treatment.

The "least quantity" estimate was developed using the following assumptions:

- The annual rainfall will be 40 inches per year, of which 75 percent will be trapped in the lagoon and 25 percent will recharge the groundwater or evaporate.
- The rainfall collection area is 12.7 acres.
- Rainfall will collect in the lagoon for 2 years (the assumed time between when EMPAK leaves the site and when a new treatment system is

operating at the site). After 2 years the lagoon oil will have been removed and evaporation of the lagoon water will increase so that there will be no further rainwater accumulation.

- After the lagoon sediment is removed (40,000 cubic yard case), three lagoon volumes of water will be treated. (One lagoon volume is the water that would remain in the lagoon between the water table and the base of the cleaned lagoon; about 8 million gallons per lagoon volume for this case).

The "greatest quantity" estimate for the costing of lagoon water treatment was developed using these assumptions:

- The annual rainfall will be 40 inches per year.
- The rainfall collection area is 12.7 acres.
- For the first 2 years, all of the rainwater will accumulate in the lagoon with no evaporation or groundwater recharge.
- After the first 2 years the lagoon oil will have been removed and for the next 2 years, until the project is completed, 50 percent of the rainwater that accumulates in the lagoon will be removed by evaporation.
- After the lagoon sediment is removed (80,000 cubic yard case) five lagoon volumes of water will be treated. (One lagoon volume is the water that would remain in the lagoon between the water table and the base of the cleaned lagoon; about 11 million gallons per lagoon volume for this case).

The onsite treatment cost estimate includes the capital cost for the treatment plant and the operation costs for the system (labor, chemicals, energy, and sludge disposal). The capital cost and operation costs for onsite water treatment are based on a system that is similar to the treatment facility that is currently at the

site, with the exception that a cost estimate for sludge handling and disposal is included. The offsite treatment cost estimate includes labor (to load the hauling vehicle), transportation costs, and the disposal fee at the Dupont Chambers Works.

<u>Alternative</u>	<u>Cost (Millions of Dollars)</u>	
	<u>4.4 x 10<sup>7</sup> gal</u>	<u>9.5 x 10<sup>7</sup> gal.</u>
Onsite treatment	4.08	7.76
Offsite treatment	7.21	15.4

From the cost estimates shown, it is apparent that onsite water treatment is about one-half the cost of offsite water treatment (at the Dupont Chambers Works).

#### Recommendation for Lagoon Water Disposal:

From the previous discussion, onsite treatment of the lagoon water is about equal with offsite treatment in terms of technology status, level of cleanup achievable, risk and effect of failure, ability to meet public health and environmental criteria, and the time required to achieve cleanup. Offsite treatment is slightly favored with respect to ability to meet legal and institutional requirements. Onsite water treatment is favored in terms of minimizing community impacts. In terms of costs, onsite treatment costs about half as much as offsite treatment at the Dupont Chambers Works.

It is recommended that onsite water treatment be used for the treatment of contaminated water in the lagoon. The system that is currently at the site is apparently providing adequate treatment, so onsite treatment is proven to be effective, and onsite treatment is estimated to cost about half as much as offsite treatment.

#### 5.3.1.4 Lagoon Cleanout

From the discussion presented in Section 4 of this report, it is evident that removal of the contaminated lagoon oil, water, and sediment is the only alternative available, since all options that left these wastes in place were screened from further consideration. The actual method of lagoon cleanout will be contingent on a number of factors, including site conditions that may become evident during the cleanout operation, as well as the preferences of cleanout contractors. This subsection presents a brief discussion of possible removal techniques for the lagoon oil and sediment, including cost estimates for these removal actions. Section 5.5 provides a discussion of the overall phasing of the lagoon cleanout and the other recommended actions for the BROS Site.

#### Oil Removal

As previously mentioned in the lagoon sediment disposal discussion, it is important that the lagoon oil and lagoon sediment do not become mixed so that the oil and sediment can be removed from the lagoon separately, allowing them to be fed into the incinerator at the optimum proportions with respect to one another. In order to accomplish this goal, a method of oil removal has been conceptually developed in this Feasibility Study.

This oil removal method involves using a floating oil skimmer pump to pump the oil from the surface of the lagoon to an oil/water separator. The oil effluent from the oil/water separator is then sent to a holding tank until it is ready to be fed to the incinerator. Also included in this oil removal method is a floating oil baffle that would be used to hold the floating oil in one part of the lagoon so that the floating oil will not interfere with the sediment removal that is expected to be taking place (concurrent with oil removal) in some other area of the lagoon.

The cost estimates presented below include the capital cost for the oil removal equipment (i.e., surface oil skimmer pump, floating oil baffle, oil/water separator, 50,000 gallon holding tank, and miscellaneous piping and electrical equipment) and

the operation and maintenance cost for the oil removal system. Appendix C of this report presents the cost estimate sheets for oil removal.

<u>Alternative</u>	<u>Cost (Millions of Dollars)</u>	
	<u>2 x 10<sup>6</sup> gal</u>	<u>3 x 10<sup>6</sup> gal</u>
Oil Removal	0.35	0.44

#### Sediment Removal

Sediment removal from the BROS lagoon is scoped to involve the use of a dragline to dredge the sediment from the bottom of the lagoon. Other methods of removing the lagoon sediment are also available, and the actual method for sediment removal will be determined during the final design; nevertheless, for costing purposes, this study assumes that sediment removal will be performed by dragline. The cost estimates presented below include the capital cost for the dragline and the cost for the construction of nine large (5,500 cubic yard capacity) lagoon sediment dewatering bins. The sediment removal, as scoped in this study, involves removing the sediment from the lagoon and placing it in these dewatering bins to allow the sediment to dry before being incinerated. The free liquids that drain from these bins will be piped to the onsite water treatment facility for treatment and discharge. Also included in the sediment removal cost estimate is the operation and maintenance of the sediment removal system, and the estimated cost to remove, decontaminate, and dispose of large objects that are suspected to be in the lagoon, such as tank cars and tank trucks.

<u>Alternative</u>	<u>Cost (Millions of Dollars)</u>	
	<u>40,000 yd<sup>3</sup></u>	<u>80,000 yd<sup>3</sup></u>
Sediment Removal	6.15	10.3

The 40,000 cubic yard case assumes the removal of a 2-foot-thick layer of sediment from the bottom of the lagoon; the 80,000 cubic yard case assumes the removal of a 4-foot-thick layer of sediment. Also included in the above sediment

removal estimates is the cost for scraping and/or dredging 6 to 12 inches of surface soil from approximately 3 acres of visible surface soil contamination east of the lagoon. The cost estimate sheets in Appendix C provide more detail into how these estimates were developed.

One other action that has been included with the cost estimate for lagoon sediment removal is the exploration for buried drums around the site and the disposal of any buried drums that are found. This action has been included with sediment disposal because the exploration for and disposal of drums is expected to be small in scope and small in cost, as compared to other site actions, and because the only evidence of buried drums are the results from the magnetometer survey which suggest that areas of buried ferromagnetic materials may exist. Since very little is known about whether buried drums exist at the site, many assumptions had to be made in order to develop a cost estimate for this action. The cost estimate presented below assumes that 100 drums, buried to a depth of 5 feet, exist around the site. In order to remove the drums, 3,515 cubic yards of soil will need to be excavated; this excavated soil is assumed to be contaminated and will require disposal at a chemical-waste landfill. The 100 uncovered drums will be overpacked and then hauled to a chemical waste landfill for disposal.

<u>Alternative</u>	<u>Cost (Millions of Dollars)</u>
Buried Drum Excavation and Disposal	1.46

The above cost estimate for drum excavation and disposal is admittedly only an order-of-magnitude value, since very little information on the presence of buried drums is available; nevertheless, this ballpark cost estimate can provide a general idea of the cost for this action.

#### 5.3.1.5 Lagoon Closure

Two options have been identified for the final closure of the BROS lagoon. These options are:

- Backfill, regrade, revegetate, and allow to drain to Little Timber Creek.
- Revegetation and leaving the lagoon as a pond

#### General Description

Backfill, regrade, revegetate, and allow to drain to Little Timber Creek.

Under this alternative (hereafter referred to as the backfilling option) the lagoon would be backfilled to above the high water table elevation, regraded, and revegetated. The contours of the backfilled lagoon would be such that rainwater runoff would discharge into the Little Timber Creek Swamp and would not collect in the lagoon area. Also, a security fence with signs would be installed to warn against and reduce the possibility of unauthorized entry. Consideration was given to installing an impermeable cap over the lagoon area; however, this consideration was eliminated for two reasons: (1) all or nearly all of the contaminated soil and sediment in the lagoon area will be removed and (2) any remaining contaminated material would most likely be below the water and in direct contact with the groundwater. Therefore, an impermeable cap would not reduce the possibility of groundwater contamination from this source since impermeable caps are designed to reduce groundwater contamination resulting from the leaching of wastes (located above the water table) by rainwater infiltration.

Revegetation and leaving the lagoon as a pond:

Under this option (hereafter referred to as the pond option) the lagoon would not be backfilled. Instead, the lagoon sides would be contoured and revegetated, and the cleaned lagoon would remain as a pond. Also, a security fence with signs

explaining the hazardous nature of the closure area would be installed around the site to reduce the potential for unauthorized entry. Since the semi-impermeable, oily sediment/sludge layer of the lagoon would be removed, the lagoon level would be able to fluctuate with the water table and the lagoon level would not continue to rise as it does now. With this option, the lagoon would be expected to behave in much the same manner as the adjacent Gaventa and Swindell Ponds.

#### Evaluation of Alternatives:

##### Technology Status:

The technology status of each of the lagoon closure options is well-established and commonly used.

##### Risk and Effect of Failure:

The risk of failure of either of these options is very low. Failure would be identified as the lagoon's not communicating with the groundwater and instead accumulating water. The risk of this occurring is the same in either case since this failure would be associated with the sediment cleanout and not the closure. The effect of failure in either case would also be the same. For the backfilling option, the lagoon level would rise from rainwater infiltration through the cover until it reached the level at which it would flow into Little Timber Creek. For the pond option, the lagoon level would rise from rainwater accumulation until the pond overflowed into Little Timber Creek. In either case, it should be noted that the water level would not rise as quickly as it does now because of increased permeability of the sediment and removal of the floating oil layer that prevented evaporation.

##### Level of Cleanup/Isolation Achievable:

The backfilling option would achieve a higher degree of isolation than the pond option because if any contaminated material remained in the lagoon, the backfill

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would effectively prevent human contact with it (although environmental contact would not be reduced). For the pond option, however, if any contaminated material remained at the base of the lagoon, human contact with the waste could occur if someone were to trespass into the lagoon area and go swimming.

Another potential contact problem that exists for the pond option would be bioaccumulation of PCBs in the food chain. If not all of the PCB-contaminated waste is removed from the lagoon, then it is possible that plant life growing within the pond would accumulate PCBs. These plants could then become a source of PCB in waterfowl that land at the site. Sportsmen who hunt these waterfowl could potentially become exposed to PCBs through ingestion.

#### Ability to Minimize Community Impacts:

Neither closure alternative would adversely affect the local community. However, local residents may perceive the backfilling option as being safer than the pond option, since the image of a pond in the lagoon area may make them feel that the problem is still at the site. Also, leaving the lagoon as a pond may be an invitation for unauthorized entry to take place, although the fence and warning signs should reduce the potential for that occurrence. The pond option could be made more favorable by planting coniferous trees around the site to prevent people in the local community from seeing the closed lagoon.

#### Ability to Meet Relevant Public Health and Environmental Criteria:

The lagoon closure options are equivalent in their ability to meet public health and environmental criteria.

#### Ability to Meet Legal and Institutional Requirements:

The lagoon closure options are roughly equal in their ability to meet legal and institutional requirements.

**Time Required to Achieve Cleanup/Isolation:**

The time to complete the pond option would be less than the backfilling option because the backfilling option requires that more than 100,000 cubic yards of backfill material be brought to the site. Nevertheless, either closure alternative should be able to be completed in less than one construction season.

**Acceptability of Land Use After Action:**

The lagoon closure options are equivalent in this respect because access to the site would be restricted in either case.

**Costs:**

The costs for the two lagoon closure options are presented below. For the backfilling option, the cost estimate includes backfilling with gravel to above the water table (for stability), followed by banksand and common borrow to achieve the desired contours. This cost also includes a topsoil cover and revegetation. The pond option cost estimate includes only topsoil and revegetation. Both cost estimates include all necessary labor. The cost for fence installation is not included since a fence already exists at the site.

<u>Option</u>	<u>Cost (Millions of Dollars)</u>		
	<u>40,000 yd<sup>3</sup></u>	<u>80,000 yd<sup>3</sup></u>	<u>30-year O&amp;M Present Worth</u>
Backfilling and revegetation	1.29	2.02	0.141
Revegetation and leaving the lagoon as pond	0.211	0.211	0.203

#### **Recommendation for Lagoon Closure:**

From the previous evaluation, it was determined that the backfill option and the pond option are about equal in terms of technology status, risk and effect of failure, ability to meet health and environmental criteria, and ability to meet legal and institutional requirements. The backfilling option was slightly favored in terms of community impacts and more heavily favored in terms of the level of isolation achievable. The pond option was slightly favored with respect to the time to implement.

In terms of cost, the pond option is substantially cheaper than the backfilling option, being about an order of magnitude less expensive.

Based on the low risk associated with both of these closure options and based on the substantial cost difference, it is recommended that the cleaned lagoon be closed by revegetating its sides and allowing it to remain as a pond.

#### **5.3.2 Tank Farm**

Only two alternatives pertaining to the tanks and tank wastes at the BROS Site passed the initial screening phase. These alternatives are:

- Removal of tank wastes and cleaning of tanks
- Complete removal of tanks and waste

It is obvious that in all cases concerning effectiveness, complete removal of the tanks and waste is equal or superior to the option of removing the waste and leaving the cleaned tanks on site. With complete removal of the tanks and waste there would be no chance for rainwater to accumulate in the tanks, there would be no possibility of unauthorized access into the tanks, and there would be no incentive for unauthorized disposal of wastes in the tanks. Community impacts would be more favorable for the complete removal option as compared to leaving the cleaned tanks on site, because tanks would no longer be present at the site and

local citizens would see a definite improvement at the site. Also, the level of cleanup would be greater for the complete removal option, even though the time to achieve cleanup would be about the same for both options. Most importantly, complete removal of the tanks and waste would greatly increase the available working space at the site. This additional work space is essential if the lagoon cleanup activities are to occur.

Costs:

The costs presented below include removal, transportation, and disposal of the waste, and cleaning of the tanks (including wipe samples of the cleaned tanks to ensure that they have been effectively decontaminated). The complete removal option also includes the cost for demolition, removal, transportation, and disposal of the tanks at a scrap yard. Neither a disposal fee for the tanks nor any salvage value for the tanks has been included.

Based on the results from the NUS tank farm sampling (summarized in Section 3.2.4), tank waste disposal is expected to include the following:

- 28,000 gallons of aqueous liquid waste to a nearby industrial wastewater treatment facility
- 310,000 gallons of oil, sludge, and highly contaminated aqueous liquids to a nearby hazardous waste incinerator.
- 413,000 gallons of PCB-contaminated liquids to a PCB-approved incinerator. (The cost estimate assume that the aqueous phase of tank 69 will require disposal as a PCB-contaminated material, as discussed in Section 3.2.4).

<u>Alternative</u>	<u>Cost (Millions of Dollars)</u>
Removal of tank waste and cleaning of tanks	3.53
Complete removal of tanks and waste	4.14

From the above cost estimates, it is apparent that complete removal of the tanks and waste is only slightly more expensive than leaving the cleaned tanks on site.

Based on the overall phasing of the site remediation, which is discussed in Section 5.5, the action of stabilizing the lagoon dike has been included with the tank farm alternatives. Since the tank cleanup is expected to be the first activity performed at the site, and since the actual lagoon cleanup may not begin for one or more years after the tank farm actions are performed, it has been decided that some action should be taken in the interim to reduce the possibility of the lagoon dike failing. Therefore, included in the cost for the tank farm action is the cost for stabilizing the lagoon dike. Both of the tank farm cost estimates presented above include the cost to stabilize the eastern lagoon dike by adding a 10-foot-thick layer of rip-rap to the outside face of the dike. The cost estimate for this stabilization action is about \$126,000. It should be noted that if seepage forces through the dike are the primary concern, then rip-rapping the dike will not be an effective control, and sheet-piling may instead be needed. The cost for sheet-piling the eastern lagoon dike is estimated to be about \$1 million. (The sheet-piling cost has not been included in the tank farm cost estimates.) Appendix C provides more detail into how these cost estimates were developed.

One other point, with respect to the disposal of the tank wastes, is worthy of note. Up until now, it has been assumed that the tank wastes will be disposed of offsite; however, as the tank sampling has shown, a substantial quantity of oil remains in the tank farm. Since the lagoon waste disposal evaluation has determined that, at this time, onsite incineration is the most cost-effective method to dispose of the

lagoon waste, a double cost savings to the overall project could be realized if the oil in the tank farm could be somehow stored on site until the lagoon waste incineration is performed. By storing the tank farm oil on the site, the oil could be used as supplemental firing fuel for the onsite incinerator. The result would be that less fuel for the onsite incinerator would need to be purchased and the transportation and disposal costs for offsite disposal of the tank farm oil would be eliminated. Assuming that the oils from various tanks in the tank farm are compatible, these oils could be consolidated and stored on the site without interfering with other site activities. Furthermore, one or more of the most stable tanks of the tank farm could be used to consolidate and store the tank farm oil. Unfortunately, regulatory considerations may cause the onsite storage of the tank oil to be unfavorable. Therefore, from this point forward in this study, it will be assumed that all tank farm wastes will be disposed of off site.

#### **Recommendation for the Tank Farm:**

It is recommended that the tanks and tank waste be completely removed from the site. This recommendation is based on several factors. First, and foremost, is the fact that the recommended lagoon action presented in Section 5.3.1 requires that the tanks be removed from the site so that there is sufficient room to set up the onsite incinerator and lagoon waste removal equipment. Second, complete removal of the tanks is equal to or superior to the option of leaving the cleaned tanks on site for all effectiveness considerations. Finally, the incremental cost to demolish and remove the tanks rather than leaving them on site is not significant when compared with the cost for other actions at the site.

### **5.3.3 Residential Wells**

From the initial screening of alternatives, all three residential well options were retained for further consideration. These options are:

- No action/monitoring
- Carbon filtration of each well
- Pipeline extension from the Pennsgrove water system

It should be noted that even if all of the contaminated material is removed from the site and further groundwater contamination is stopped, action is still warranted for the residential wells because the contamination that is currently in the groundwater will continue to threaten these wells.

#### General Description

As discussed in the groundwater section of this report (Section 3.2.2), only nine residential wells will be considered for remedial action at the BROS Site. These wells are: Keller (Van Scoy), Fish Diesel Repair (Smith's Garage), Byrnes, Lindle, Cahill, Newton, Fryberger, Hillman, and Bell. The reasons for choosing these wells were outlined in Section 3.2.2. Although the Pepper Industries well is located within the area of influence of the BROS Site, this well will not be considered for remedial action since it is no longer used.

#### No Action/Monitoring:

The no action/monitoring option (hereafter referred to as "no action") involves only performing periodic sampling of the residential wells. In the scoping of this option, it was assumed that all nine wells would be sampled quarterly for volatile organics and annually for the full HSL. Also included would be the sampling of six monitoring wells in order to determine if a plume "wave front" was approaching the residential wells. Since the Keller well already has a carbon filtration unit, the no-action option would allow for the carbon filter to be changed annually. A disadvantage of this option is that it only monitors contamination but does nothing to reduce or eliminate the contamination. Therefore, if unacceptable levels of contaminants are detected in the water, some other action would still need to be taken.

#### Carbon Filtration of Each Residential Well:

This option (hereafter referred to as the carbon filter option) involves installing a granular activated carbon filter on each individual well. The carbon filter acts to purify the well water by adsorbing chemical contaminants. Also included in the carbon option would be the same monitoring program as for no action, with the exception that two samples would be collected from each residential well (i.e., before and after the carbon filter). The carbon option is scoped to also involve annual changing of the carbon in each carbon filter.

#### Alternate Water Supply - Pipeline from Pennsgrove Water Supply Company:

This system (hereafter called the "pipeline" option) involves the installation of a potable water pipeline from the Pennsgrove water system to the affected residents. For the purposes of this Feasibility Study, the pipeline route is assumed to begin at the current system terminus at Steelman Avenue. The pipeline is assumed to follow along Crown Point Road, passing under Route 130, and finally ending in the immediate vicinity of the Bell, Hellman, and Fryberger residences. Additionally, a second pipeline is assumed to branch from this main extension at a point near the Byrne residence. This branch from the main extension would pass by the Byrne residence and extend to the Keller residence and Fish Diesel Repair. The pipeline, as scoped for this study, would not provide for fire protection. The pipeline option would not require any ongoing residential well monitoring and would effectively isolate the residents from the contaminated groundwater. Sealing of the residential wells would also be considered under this action.

One potential problem associated with the pipeline option is that the New Jersey Division of Water Resources issued an Administrative Order to the Pennsgrove Water Supply Company on December 8, 1981. According to this Order, no new extension to the Pennsgrove system will be allowed until various system improvements are made. (These improvements include the construction of a new, duplicate supply well and the replacement of undersized water mains). However, representatives of the NJDEP indicated that this Administrative Order would be

waived to allow an extension of the Pennsgrove system in order to supply potable water to residents that have contaminated wells.

### Evaluation of Alternatives

#### Technology Status:

The technology status of each of the three well options is well established and commonly used. Therefore, in terms of technology status, each of the well options is roughly equivalent.

#### Risk and Effect of Failure:

In terms of risk and effect of failure, the pipeline alternative would show the least risk. The carbon option would be ranked second, since there is a considerable risk that contaminants could break through the carbon filter, especially if contaminant levels would quickly and unexpectedly increase. The effect of a failure with respect to the carbon option would be the possibility of residents drinking contaminated water until the results from the next sampling round indicated the breakthrough. The no-action option would present the greatest risk, and a failure would result in the drinking of contaminated water by the residents. Also, if unacceptable levels of contamination are detected in the residential wells, the no-action alternative would be useless and some other action would need to be taken. For the carbon option, however, the carbon changing rate could be accelerated if breakthroughs are observed.

#### Level of Cleanup/Isolation Achievable:

Once again, the pipeline option is rated the highest with respect to the other two residential well options because the pipeline would effectively isolate the residents from the contaminated groundwater. Carbon filtration would rank second because although the groundwater would still be used, the carbon filter would remove some or all of the contaminants and thereby partially isolate the residents from the

contaminated groundwater. The no-action option rates the lowest since no cleanup or isolation is achieved under this option.

**Ability to Minimize Community Impacts:**

It is obvious that the pipeline option would be, by far, the most favored by local residents. Furthermore, installation of the pipeline would not significantly disrupt the everyday life of the community. Carbon filters would be viewed less favorably, since many residents may be skeptical of their effectiveness; nevertheless, carbon filters would be favored over the no-action option. Also, under the carbon filter and no-action options, residents may be disrupted slightly by the need for periodic water monitoring and carbon changing.

**Ability to Meet Relevant Public Health and Environmental Criteria:**

The pipeline option would best meet public health criteria since it is assumed that the municipal water system distributes water of satisfactory quality. The carbon filter option would be second best since the possibility exists that contaminants could break through the carbon and cause the domestic water quality to temporarily exceed drinking water standards. This situation could be rectified by changing the carbon more frequently. The no-action alternative would do nothing to meet public health criteria, except to indicate when water quality standards are being violated.

**Ability to Meet Legal and Institutional Requirements:**

No legal or institutional requirements have been identified for the no-action or carbon options. Permits to install the pipeline may be required; however, these permits should not be difficult to secure, assuming that a waiver on the aforementioned Administrative Order can be obtained.

**Time Required to Implement the Action:**

The no-action and carbon options could be implemented immediately. The pipeline option, on the other hand, would take from 1 to 3 months to actually install, once work began.

**Acceptability of Land Use After Action:**

The pipeline option would be ranked the highest with respect to the acceptability of land use after the action since the installation of a potable water pipeline could possibly increase the value of the property in the area and would provide flexibility for any subsequent land development in the area. The carbon filter and no-action options, on the other hand, may deter any subsequent land development in the site vicinity because developers would realize that the only water source currently in the area is contaminated or potentially contaminated groundwater.

**Costs:**

The costs presented below are broken down into capital costs and annual operation and maintenance (O&M) costs. The O&M costs are also converted to a 30-year present worth (assuming 10 percent interest and 0 percent inflation). The pipeline capital cost includes materials and labor to install a 6-inch-diameter pipeline for a length of 8,000 feet, including nine home connectors, excavation, backfill, meter boxes, and repaving. Pipeline O&M costs include the cost for water service and the base annual service charge. Carbon filter capital costs include material and labor to install the carbon filter. The carbon filter option annual O&M cost includes labor and analytical costs for the monitoring program outlined in the option description, and labor and materials for annually changing the carbon. The no-action option has no capital costs; the O&M costs include labor and analytical costs for monitoring. All work is assumed to be performed by local workers. Additional detail for these estimates is presented in Appendix C of this report.

Alternative	Cost (Millions of Dollars)		
	<u>Capital</u>	<u>Annual O&amp;M</u>	<u>30 year O&amp;M present worth</u>
No Action	0	0.032	0.301
Carbon filtration	0.018	0.051	0.484
Water pipeline	0.292	0.002	0.020

From the above costs it is obvious that the pipeline option has the highest capital cost by far. However, when the capital cost and the 30-year O&M present-worth costs are added, the pipeline option is the least expensive followed by no action and the carbon filter option.

#### Recommendation for Residential Wells:

From the previous evaluation of the residential well alternatives, it is evident that providing a potable water pipeline to the affected residents is the most effective option. The pipeline option was favored over the carbon filter and no-action alternatives in terms of risk and effect of failure, level of isolation achievable, community impacts, ability to meet public health criteria, and acceptability of land use after the action.

With respect to costs, the pipeline option has by far the largest capital cost; however, when the costs for long-term maintenance and monitoring are included, the pipeline option is the least expensive. Furthermore, the pipeline option solves the problem of contaminated domestic wells, whereas the no-action option only monitors the problem. If substantially more contamination begins to appear in the residential wells then the no-action option will only be able to alert the people to the fact that some other action is needed, and the carbon filter option may become ineffective; on the other hand, regardless of the contaminant levels in the domestic wells, the pipeline option would continue to provide potable water to the residents.

It is recommended, based on the previous evaluation, that a potable-water pipeline be installed so as to provide the affected residents in the vicinity of the BROS Site

with a suitable water supply. The Pennsgrove Water Supply Company is the likely source of water for this pipeline since it is located near the affected residents. It is recommended that the pipeline be installed and operating before the lagoon sediment is disturbed, because it is possible that lagoon sediment dredging will cause a wave of increased groundwater contamination and migration to occur.

#### 5.3.4 Groundwater

From the initial screening of alternatives; two options pertaining to the groundwater contamination in the vicinity of the BROS Site have been retained for further consideration. These options are:

- No action
- Groundwater extraction and treatment

It should be noted that the evaluation of residential well alternatives has determined that a potable water pipeline should be installed from a nearby municipal water system; therefore, the no-action alternative with respect to groundwater cleanup is viable since the local residents would be isolated from the groundwater contamination.

#### General Description

##### No Action:

The no-action alternative with respect to groundwater contamination would involve taking no action to prevent the migration of contaminated groundwater or to clean up the contaminated groundwater. Based on the NJDEP groundwater monitoring requirements that were defined for a nearby site that was suspected of contaminating the groundwater, continued long-term groundwater monitoring is expected to be required under the no-action option. This monitoring scenario is expected to include the quarterly sampling of 16 wells with analyses for arsenic, chloride, lead, oil and grease, sulfate, total dissolved solids, and total organic

carbon being performed annually, and analyses for pH, specific conductance and total volatile organics being performed quarterly.

#### Groundwater Extraction and Treatment:

The groundwater extraction and treatment option would involve placing extraction wells in and around the BROS lagoon and pumping these wells at a specified rate in order to remove the contaminated groundwater from the underlying aquifer. The extracted groundwater would be treated to remove the contaminants and the treated water would be discharged to Little Timber Creek.

Based on the groundwater modeling that was discussed in Section 3.2.2, the groundwater extraction and treatment alternative presented in this evaluation involves the placement of 32 groundwater extraction wells on the BROS Site. These wells would be each pumped continuously at a rate of 20 gpm (for a combined total of 640 gpm) over a 5-year period in an effort to remove a substantial portion of the contaminated groundwater. Activated carbon adsorption is assumed to be the only treatment process necessary to adequately treat the extracted groundwater. Alternatively, air stripping or a combination of air stripping and carbon adsorption, could be appropriate for treatment of the extracted groundwater; however, potential air discharge problems associated with the air stripping of volatiles from the extracted groundwater have caused air stripping to be eliminated from consideration as a treatment process in this evaluation.

The groundwater extraction and treatment option is also expected to include the same long-term monitoring requirements that were outlined in the no-action alternative discussion.

### Evaluation of Alternatives

#### Technology Status:

The technology status of both of the groundwater alternatives is well established and commonly used. Groundwater extraction and treatment techniques have been used with success at other sites, and continued monitoring is a common practice. Therefore, in terms of technology status, each of the groundwater options is roughly equivalent.

#### Risk and Effect of Failure:

Failure with respect to the no-action alternative is identified as continued migration of contaminated groundwater to the point where additional wells in the area would become contaminated. Alternatively, failure could be defined as someone unknowingly developing the local groundwater for domestic use. The effect in either case would be the health hazard associated with drinking the contaminated groundwater. However, if the recommended potable water pipeline is installed, then the risk would be very low. Furthermore, since the groundwater movement in the BROS Site vicinity is very slow, contaminant migration is expected to occur at a very low rate.

For the extraction and treatment option, failure could be defined as inadequate water treatment resulting in contaminated water being discharged to Little Timber Creek; however, monitoring of the treatment system effluent would significantly reduce this possibility. Another failure could be defined as the groundwater extraction system not being able to adequately extract or contain the plume of groundwater contamination. The effect of such a failure would be the expenditure of a large amount of money without realizing a significant benefit.

With respect to risk and effect of failure, the groundwater extraction and treatment option is slightly favored over the no-action alternative because of the

potential (albeit unlikely) public health hazard associated with leaving the contaminated groundwater in place.

**Level of Cleanup/Isolation Achievable:**

It is obvious that the groundwater extraction and treatment option is favored, by far, over the no-action alternative with respect to the level of cleanup achievable; however, assuming that the recommend potable water pipeline is installed, there would be a degree of isolation provided with the no-action alternative. Therefore, the extraction and treatment alternative is only slightly favored over the no-action option with respect to level of cleanup/isolation achievable.

**Ability to Minimize Community Impact:**

Assuming that the pipeline from a nearby municipal water system is installed, neither groundwater alternative is expected to have much of an impact on the local community. Nevertheless, groundwater extraction and treatment is slightly favored over no action because the community is expected to favor cleanup over no action, if only for aesthetic reasons.

**Ability to Meet Relevant Public Health and Environmental Criteria:**

With respect to this evaluation criterion, groundwater extraction and treatment is favored over no action because under the extraction and treatment option an attempt would be made to meet all relevant public health and environmental criteria by cleaning up the groundwater. The no-action alternative, on the other hand, allows the contaminated groundwater to remain in place where it could still pose a threat to public health and the environment.

**Ability to Meet Legal and Institutional Requirements:**

The two groundwater options are about equal in terms of legal and institutional requirements. The groundwater extraction and treatment alternative would need

discharge permits for its treatment system, as well as the appropriate permits for the installation and operation of the extraction wells. The no-action alternative would not require any permits; however, since plumes of contaminated groundwater have been defined as hazardous waste by RCRA, there may be some institutional problems associated with leaving the contaminated groundwater in place.

Time Required to Implement the Action:

This evaluation criterion is not really applicable to the two groundwater options. The no-action alternative can be implemented immediately while the groundwater extraction and treatment option is scoped to take 5 years to achieve reasonable cleanup; however, the extraction and treatment alternative provides a definite benefit whereas no benefit is realized under the no-action option. On this basis it is not applicable to compare the two alternatives in terms of time required to implement the action.

Acceptability of Land Use After Action:

Groundwater extraction and treatment would be slightly favored over no action with respect to the acceptability of land use after the action. Assuming that the extraction and treatment option provides satisfactory groundwater cleanup, the land in the vicinity may be more valuable for development since the underlying groundwater resources would be useable; nevertheless, if the recommended water pipeline is installed, then the no-action alternative could be implemented without significantly affecting the acceptability of the local land for development since a reliable source of potable water would be available.

Costs:

Two sets of cost estimates are presented below for the groundwater alternatives. The first set of cost estimates shows the capital costs and annual O&M costs for no action and groundwater extraction and treatment. From the first set of estimates it is obvious that the no-action alternative has neither capital costs nor O&M

costs. The extraction and treatment capital cost estimate includes the cost for the installation of 32 extraction wells (as scoped in the groundwater modeling discussion in Section 3.2.2), as well as the cost for pumps, piping, treatment system housing, and miscellaneous electrical work. The annual O&M cost for groundwater extraction and treatment includes the cost for activated carbon, rental of the carbon adsorption units, labor to operate the system, energy requirements, treatment system effluent monitoring, and general maintenance. Under the extraction and treatment option it is assumed that the system will operate continuously at 640 gpm (20 gpm per well). Since the groundwater extraction and treatment option has been modeled to operate for 5 years, the annual O&M cost has been converted to a 5-year present worth (assuming 10 percent interest and 0 percent inflation). Additional detail on the breakdown of these estimates is provided in Appendix C.

<u>Alternative</u>	<u>Cost (Millions of Dollars)</u>		
	<u>Capital</u>	<u>Annual O&amp;M</u>	<u>5-Year O&amp;M Present Worth</u>
No Action	0	0	0
Groundwater Extraction and Treatment	0.83	1.43	5.41

From the above cost estimates it is evident that the groundwater extraction and treatment alternative is far more costly than no action. These cost estimates do not include the cost for long-term groundwater monitoring, which is expected to be exactly the same regardless of the groundwater option that is selected. The second set of cost estimates presented in this discussion gives the annual monitoring cost estimate and the 30-year present worth (assuming 0 percent inflation and 10 percent interest) for long-term groundwater monitoring. Groundwater monitoring requirements (based on the requirements imposed by NJDEP on a nearby site with groundwater contamination) are expected to include the quarterly sampling of 16 monitoring wells with pH, specific conductance, and total volatile organics analyses being performed on a quarterly basis, and arsenic, lead, chloride, oil and grease, sulfate, total dissolved solids, and total organic carbon analyses being performed on an annual basis.

<u>Alternative</u>	<u>Cost (Millions of Dollars)</u>	
	<u>Annual Monitoring</u>	<u>30-year Present Worth</u>
No Action	0.030	0.281
Groundwater Extraction and Treatment	0.030	0.281

Appendix C of this report gives additional detail on the development of these long-term groundwater monitoring cost estimates.

#### Recommendation for Groundwater:

Based on the previous discussion of groundwater alternatives, the groundwater extraction and treatment alternative was slightly favored over the no-action alternative with respect to risk and effect of failure, level of cleanup/isolation achievable, ability to minimize community impacts, ability to meet relevant public health and environmental criteria, and acceptability of land use after the action. Nevertheless, one point was made clear throughout the evaluation: as long as the recommended potable water pipeline is brought into the area that has been affected by the groundwater contamination, then no substantial benefit is realized by cleaning up the groundwater as compared to the no-action alternative. Considering the enormous cost differential between no action and groundwater extraction and treatment, and considering the small differential in benefit between the two groundwater options, it is recommended that no action be taken on the existing groundwater contamination. This recommendation allows for continued, long-term groundwater monitoring and is contingent upon the installation of a potable water pipeline from a nearby municipal water system to the affected areas.

#### **5.4 Summary of Alternatives, Evaluations, and Recommendations**

From the evaluations presented in Sections 5.1 through 5.3, an overall remedial action for the BROS Site has been recommended. This recommended overall action is the combination of the recommended actions from each of the categories pertaining to some aspect of the site remediation. The various remediation categories, along with the recommended option for each category, are presented below:

- **Lagoon Waste Removal**
  - Pump out oil, pump out water, dredge sediment (assuming that EMPAK, under its present contract with the Army Corps of Engineers, will not lower the lagoon level to the point where the sediment and oil become mixed).
- **Lagoon Waste Disposal - Oil**
  - Onsite incineration.
- **Lagoon Waste Disposal - Sediment**
  - Onsite incineration.
- **Lagoon Waste Disposal - Water**
  - Onsite treatment.
- **Lagoon Closure**
  - Revegetation and leaving the cleaned lagoon as a pond.
- **Tank Farm**
  - Complete removal of the tanks and waste.
- **Residential Wells**
  - Provide a water supply pipeline from Pennsgrove Water Supply Company.

- Groundwater
  - No action/long-term monitoring (contingent on the installation of a potable water pipeline).

Incineration of the lagoon oil and sediment could be performed either on site or at an offsite facility. Open market conditions at the time that the lagoon cleanup begins will be considered in selecting the most appropriate incineration location. The cost estimates contained in this report do suggest that incineration at the BROS Site is more economical for disposal of the oil and sediment.

The estimated costs associated with this overall action are presented in Table 5-1. The method of performing the onsite and offsite work for this recommended overall action will be further detailed in the conceptual design. Section 5.5 of this report presents a preliminary overview of the phasing of the overall site remediation.

With regard to the quantity of lagoon sediment to be removed and disposed, cost estimates were developed based on 2 feet of sediment excavation and 4 feet of sediment excavation. These figures are only engineering estimates because the variation in sediment contamination with respect to excavated depth is unknown. Therefore, it is recommended that a comprehensive sampling and characterization of the lagoon sediment be performed before excavation activities begin. This characterization should attempt to determine sediment contamination versus depth so that the appropriate amount of sediment can be removed. If possible, this sampling should be performed as near as possible to the time of cleanup, since the sampling is expected to involve the placement of numerous borings into the bottom of the lagoon. These borings may act as "drains" which could allow the liquid contents of the lagoon to flow more freely into the local groundwater.

#### **5.5 Overall Phasing of the Recommended Site Remedial Actions**

This section presents a preliminary overview for the phasing of the recommended remedial actions for the BROS Site. This overview identifies a preliminary

TABLE 5-1

**COST ESTIMATES FOR THE RECOMMENDED  
OVERALL REMEDIAL ACTION  
BRIDGEPORT RENTAL AND OIL SERVICES SITE**

Action	Capital Cost <sup>1</sup> (Millions of Dollars)			30 Year O & M Present Worth (Millions of Dollars)
	Low	Mean	High	
<b>Lagoon</b>				
• Oil removal	0.35	0.40	0.44	--
• Sediment removal	6.15	8.22	10.3	--
• Onsite incineration of oil	2.12	2.65	3.18	--
• Onsite incineration of sediment	21.6	32.4	43.2	--
• Onsite treatment of water	4.08	5.92	7.76	--
• Drum Excavation and Removal		1.46		
• Lagoon closure		0.21		0.203
<b>Tank Farm</b>				
• Complete removal of tanks and waste		4.14		--
<b>Residential Wells</b>				
• Water supply pipeline from Pennsgrove Water Company		0.29		0.020
<b><u>Groundwater</u></b>				
• No Action/Long-Term Monitoring		--		<u>0.281</u>
<b>Total Cost Estimate for Recommended Actions</b>				
		55.7		0.504

<sup>1</sup> Because of the uncertainty regarding the amount of waste present in the lagoon, a range of costs has been provided for waste removal and disposal actions.

schedule for the performance of site activities and provides a brief description of the suggested methods to perform these activities.

The first activity that should be performed is the installation of a potable water pipeline to the residences that are identified as being within the zone of influence of the groundwater contamination migrating from the BROS Site. This activity should be performed first so that any potential health risks associated with the consumption of contaminated groundwater are eliminated as soon as possible. Furthermore, subsequent site activities, such as lagoon cleanout, may disturb the local groundwater system. It is possible that contaminant movement into and through the aquifer may temporarily increase as a result of disturbances caused by site cleanup.

An added advantage of the pipeline, as it is scoped in Section 5.3.3, is that the pipeline route will pass by the residences in Area 2 and Area 3 (see Figure 3-2) that have demonstrated domestic well contamination. Although the wells in Area 2 and Area 3 have not been considered for action under the BROS Site cleanup, the residents in these areas may elect, on their own accord, to connect to this water pipeline.

The first onsite activity that should be performed is the disposal of the tank wastes and removal of the tanks. This activity must be performed before lagoon cleanout activities are initiated in order to have adequate space at the site for the lagoon cleanout equipment and onsite incinerator. Since it may be necessary to mobilize an onsite incinerator at the site to conduct appropriate test burns for the permitting of the incinerator, it is imperative that the tanks be removed well in advance of lagoon cleanup.

Concurrent with the tank removal, several other site activities should be initiated. Activities associated with procuring a lagoon waste disposal contractor (either an onsite incinerator or an offsite incinerator) should begin as soon as possible since permitting requirements (especially for onsite incineration) may take one to two years to complete. Other site activities that should be performed in conjunction

with the tank removal include inspection of the lagoon dike and characterization of the lagoon sediment. Based on previous investigations and observations, it is apparent that the stability and integrity of the lagoon dike are questionable. Since lagoon cleanout may not begin for one or more years, a dike inspection should be performed and necessary corrective action should be taken to ensure that the dike does not fail in the interim. Potential dike stabilization techniques may include sheet piling (if seepage forces are a primary concern) or rip-rapping of the outside face of the dike (if dike failure is the major concern). In terms of lagoon sediment characterization, the extent of sediment contamination with depth is unknown at this time; therefore, in order to develop specifications for sediment removal (e.g., excavation down to the point where PCB concentrations are less than 50 ppm) a detailed study of the lagoon sediment needs to be performed. This study may involve establishing a grid of sediment borings over the lagoon area. In conjunction with this lagoon sediment characterization, it may be prudent to attempt to develop a reliable method of field PCB analysis so that PCB concentrations can be determined in the field during sediment excavation and disposal activities.

Another site activity that may be performed concurrent with the tank removal is the exploration for and disposal of any buried drums, and the disposal of other miscellaneous debris around the site (e.g., the abandoned tank truck east of the lagoon). Test pits should be dug in those areas in which the magnetometry data (generated during the Remedial Investigation) indicate that ferromagnetic materials may be buried. Any drums or other materials that are uncovered should be properly disposed of. However, caution should be exercised during excavation activities near the lagoon dike to ensure that the dike stability is not jeopardized. If planned excavation activities are deemed to pose a threat to the stability of the dike, then these activities should be postponed until lagoon cleanout is completed.

Removal, decontamination, and disposal of drums, tanks, and other large objects that are in the lagoon should also be coordinated with tank removal activities, if possible. Since decontamination and dismantling equipment will be on site for the tank demolition and disposal, a cost savings may be realized if disposal of other miscellaneous debris at the site can be coordinated with the tank farm remediation.

However, it may be difficult or impossible to remove some of the large objects from the lagoon before the lagoon cleanup is initiated. In this case, the difficult-to-remove lagoon debris will not be addressed until lagoon waste removal activities are in progress.

Following the removal and disposal of the tanks at the BROS Site, and following the necessary permitting activities for the onsite incinerator (or offsite incinerator, if found to be cost-effective), the lagoon cleanout activities can begin. The lagoon cleanout is expected to begin at the start of the second construction season after site remediation is initiated. The reasons that the lagoon cleanout is expected to be delayed until the second construction season are: first, the tank removal and associated activities may take up a major portion of the first construction season, and second, the permitting requirements, especially for onsite incineration, may take one to two years to complete. It may be possible to mobilize the onsite incinerator (if this is the final selected disposal method) to the site during the first construction season and to perform the appropriate test burns. If this is the case, then it may be possible to leave the incinerator on site during the winter and to begin incineration of the lagoon wastes as soon as the weather permits and as soon as appropriate permitting is received. (From this point forward in this discussion, it is assumed that onsite incineration will be the method of lagoon waste disposal, since onsite incineration is the technique recommended by this study).

As previously discussed in the sediment disposal evaluation, the optimum lagoon waste disposal method would be to incinerate the lagoon sediment and lagoon oil in a controlled mixture, using the superior heating value of the oil, as compared to the sediment, to minimize the need for supplemental firing fuel. In order to operate the incinerator in this fashion, the lagoon oil and lagoon sediment must be removed simultaneously, but separately, and must be temporarily stored separately. This removal technique will require that the lagoon cleanout is performed in a highly controlled and well-coordinated manner.

The first step in performing the lagoon cleanout is the establishment of an onsite water treatment facility to remove and treat the lagoon water. Concurrent with the implementation of the water treatment facility, the necessary sediment excavation equipment and lagoon oil removal equipment should be set up at the site. The lagoon oil removal equipment is expected to include a boom or curtain that would be used to move all of the floating oil to one area of the lagoon. Using a floating skimmer pump, the lagoon oil can be pumped to an oil/water separator and then to a temporary storage tank. The sediment excavation equipment may include a Sauerman dredge or a dragline. Also needed for sediment excavation would be the construction of large sediment dewatering bins (tentatively to be located along the northern shore of the lagoon) with an underdrain system that would channel free liquids from the dewatering bins to the water treatment facility.

Once the necessary equipment is in place, the removal of the lagoon wastes can begin. The lagoon oil should first be "corralled" into an area of the lagoon that is known to be relatively deep. (Since EMPAK, Inc. is now lowering the lagoon level, shallow and deep areas of the lagoon should be identified and mapped when the lagoon level is at its low point so that the locations of these areas will be well established.) Once the lagoon oil has been consolidated into one area of the lagoon, water removal and treatment should begin in order to lower the lagoon level. (In the interest of expediting the cleanup, lagoon water removal and treatment may be started while the remainder of the cleanout equipment is mobilized and set up; however, care should be taken so as not to lower the lagoon level to the point where the oil becomes perched on the shallow areas of the lagoon bottom.) As the lagoon level is lowered and the shallow areas of the lagoon bottom are exposed, excavation of the sediment from these areas and pumping of the lagoon oil can begin. The sediment would be dredged from the exposed areas of the lagoon bottom and sides, and would be placed in the dewatering bins. Once the sediment is sufficiently dried, it would be removed from the dewatering bins and fed into the

onsite incinerator. The appropriate amount of lagoon oil would be fed to the onsite incinerator as a separate stream. It is expected that several sediment dewatering bins will be constructed at the site so that as one bin is being fed to the incinerator other bins will be in progressive stages of dewatering.

As the shallow areas of the lagoon are cleaned out, and as the lagoon level continues to drop, it may be easiest to construct a roadway down into the cleaned areas of the lagoon so that the excavation equipment (i.e., dragline) can have better access to the area that is being dredged. Alternatively, all dredging may be performed from the shores of the lagoon by using a Sauerman dredge.

Once all of the lagoon oil and contaminated sediment has been removed, it is expected that some water will remain in the bottom of the lagoon since the lagoon extends down into the underlying aquifer. This water will need to be treated by the onsite water treatment facility to remove contaminated material that has become suspended as a result of dredging activities. Three or more volumes of this remaining water may require treatment.

After, or possible concurrent with the lagoon waste removal, the cleanup of approximately 3 acres of surficial contamination east of the lagoon should be performed. This surficial cleanup is expected to involve the scraping or dredging of the top 6 to 12 inches of visibly contaminated soil. This scraped material should be dewatered, if necessary, and incinerated in much the same manner as the lagoon sediment. Similarly, any other miscellaneous cleanup jobs should be performed, such as skimming any oil that may be seen floating on the Gaventa or Swindell Ponds, or scraping any other areas of visible surface soil contamination.

One aspect of the lagoon cleanout that has not been discussed in detail is the removal and disposal of debris in the lagoon. As briefly mentioned previously, some of the larger debris may be removed during tank demolition and removal activities. If any large objects in the lagoon cannot be removed at the time of tank disposal, then these objects will be removed as they are encountered. Depending on the types of large objects that are present in the lagoon, it may be necessary to

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decontaminate and dismantle them in place once the lagoon level has been lowered to the point where they are fully exposed. Small pieces of debris, such as bottles and wood, can be excavated and incinerated along with the sediment.

Following the completion of the lagoon cleanup, any remaining lagoon dikes should be pushed into the cleaned out lagoon and the exposed lagoon sides should be regraded and revegetated to complete the lagoon closure.

The overall time required for the cleanout and closure of the lagoon, based on fairly continuous operation of the onsite incinerator, is expected to be about one and a half to two and a half years.

It is expected that once the overall BROS Site remediation is completed, a long-term monitoring program will be required. This monitoring program may involve groundwater monitoring, as well as periodic monitoring of nearby surface waters, including the water remaining in the cleaned out lagoon. The specifics of the long-term monitoring program will be established by the EPA and appropriate State or local agencies.

## APPENDIX A

TREATABILITY STUDY OF DISPOSAL ALTERNATIVES FOR  
LAGOON OIL AND LAGOON SEDIMENT**A.1 Introduction**

In conjunction with the Feasibility Study that was performed for the BROS Site, a Treatability Study was conducted to evaluate disposal alternatives for the BROS lagoon oil and sediment.

Analyses conducted during the Remedial Investigation showed that PCB concentrations ranged from less than 100 to 1,380 parts per million (ppm) in the lagoon oil and from 190 to 1,400 ppm in the lagoon sediment. Table A-1 presents a summary of the observed PCB levels in the oil and sediment, as well as the oil and grease concentrations observed in the sediment. As Table A-1 illustrates, the PCB concentrations are spread over a wide range, varying by as much as an order of magnitude. Nevertheless, the average PCB concentration in each phase exceeded 500 ppm. It is interesting to note that the PCB concentration in the sediment does not necessarily follow the oil and grease concentration. The highest observed PCB level did occur in the sample with the highest oil and grease; however, the sample with the lowest oil and grease showed the second-highest PCB concentration.

Relative to the aforementioned PCB analytical results, the concentrations of other contaminants in the oil and sediment are only of minor significance in terms of disposal alternatives. The observed levels of PCBs will be the most critical factor in determining the method of oil and sediment disposal; therefore, this treatability study focuses on disposal of the oil and sediment as PCB-contaminated material.

**A.2 Disposal Options**

For materials contaminated with greater than 500 ppm PCB, the disposal options are limited. Available information indicates that the acceptable disposal options are: thermal destruction at an incinerator licensed to handle PCB; and landfilling

TABLE A-1

**SUMMARY OF PCB CONCENTRATIONS OBSERVED  
IN LAGOON OIL AND SEDIMENT DURING REMEDIAL INVESTIGATION  
BRIDGEPORT RENTAL AND OIL SERVICES SITE**

<u>Sample Identification</u>	<u>Sample Type</u>	<u>Total PCB (mg/kg)</u>	<u>Oil &amp; Grease (percent)</u>
LS-03-01	Sediment	1,400	61
LS-03-02	Sediment	450	32
LS-03-03	Sediment	210	50
LS-03-04	Sediment	190	43
LS-03-05	Sediment	600	14
	Average	570	40
LS-01-01	Oil	1,380	--
LS-01-02	Oil	600	--
LS-02-03	Oil	< 100	--
LS-01-04	Oil	200	--
LS-01-05	Oil	1,055	--
	Average	667	

Source: NUS Laboratory Services Division, Pittsburgh, Pennsylvania, August 22, 1983

at an approved chemical waste landfill (nonliquid, nonignitable PCB-wastes only). A number of other potential disposal/destruction methods are available, including dechlorination and microbial degradation.

Dechlorination processes (e.g. Acurex, KOHPEG, NaPEG, PCBX, and Goodyear) were eliminated from consideration as disposal methods for the following reasons:

- Many dechlorination processes are still in the testing phase and have not received EPA approval for commercial-scale use.
- Those processes that are EPA-approved are not suitable to the oil and sediment at the BROS Site, since many of these processes were specifically designed to treat transformer oil and other "clean" fluids.

Microbial degradation was eliminated as a possible PCB destruction technique based on current research which indicates that no specific microorganism has been discovered that will oxidize or degrade highly chlorinated biphenyls (communication with Albert Klee, EPA Research Labs, Cincinnati, Ohio, March 1984). Similarly, a site-specific study conducted by Camp Dresser and McKee, Inc. (CDM) in August 1982 concluded that biological treatment was unsuitable for treatment of the lagoon waste. Reasons cited by CDM included observed slow rates of biooxidation and the lack of evidence regarding any bacterial acclimation. This study by CDM concentrated on the treatment of the lagoon water; consequently, treatment of the oil and sediment by biological means can be considered even less feasible.

With respect to the hazardous waste landfilling of materials containing greater than 500 ppm PCB, current EPA policy seems to prohibit this alternative, especially if the PCB material is liquid or contains free liquids. The Toxic Substances Control Act (TSCA), final PCB Rule (40 CFR 761), states that any liquid material containing greater than 500 ppm PCB must be disposed of in an approved high-temperature incinerator. The Rule goes on to say that dredged materials and municipal sewage treatment sludges containing PCB shall be disposed

of in either a high-temperature incinerator or in an approved chemical waste landfill. The approved landfill must ensure that liquid materials containing more than 500 ppm PCB are not disposed in the landfill. Furthermore, processing liquid PCB-materials into solid PCB-materials is only permitted for liquids containing less than 500 ppm PCB. Based on this PCB rule, it seems apparent that the lagoon oil must be incinerated. Since the lagoon sediment is expected to contain a substantial quantity of liquid, especially in light of its saturated condition at the bottom of the lagoon and its high oil and grease content, sediment disposal may also be limited to incineration, unless some satisfactory method of dewatering can be implemented or approval to solidify the sediment is received.

There is, however, one contingency that is available under the PCB Rule for materials containing more than 500 ppm PCB. An alternate method of PCB material disposal can be implemented if specifically approved by the EPA Regional Administrator. In general, for such an approval to be received, it must be demonstrated that disposal by the methods and rules outlined in 40 CFR 760 is unreasonable or inappropriate. Although such a regional approval is considered to be unlikely, there is a possibility that one or more of the following disposal alternatives could be allowed:

- Stabilization of lagoon sediment with subsequent disposal at a chemical waste landfill.
- Stabilization of a mixture of lagoon oil and sediment with subsequent disposal at a chemical waste landfill.
- Stabilization/Fixation of lagoon sediment with in-situ disposal.
- Stabilization/Fixation of a mixture of lagoon oil and sediment with insitu disposal.

In an attempt to evaluate the effectiveness of the "Stabilization/Fixation with Insitu Disposal" options, samples of the lagoon sediment and lagoon oil were

collected and were sent to Velsicol Chemical Corporation to undergo stabilization. Two sediment samples were stabilized using different curing methods and one sediment/oil mixture was stabilized. One sediment sample was left unstabilized as a control. All of the samples were then sent to a Contract Laboratory to undergo EP Toxicity and ASTM leaching procedures. The leachates from each of these leaching procedures were then analyzed for HSL organics, excluding volatiles, and HSL inorganics.

In none of the samples tested, including the unstabilized sediment sample, were inorganics found in the leachate at concentrations above the EP Toxicity criteria. Nor were PCBs detected in any of the leachates. However, levels of organic contaminants found in the leachate from the stabilized samples were much higher than for the leachate from the unstabilized, control sample. For example, 2,4-dimethylphenol appeared in the leachate of the stabilized samples at concentrations ranging from 460 to 5,400  $\mu\text{g/l}$ , while the unstabilized sediment sample showed 2,4-dimethylphenol concentrations of 12 and 18  $\mu\text{g/l}$  in the leachate. Similar order of magnitude differences in organic concentrations in the leachate from stabilized versus unstabilized samples were observed for phenol, 4-methylphenol, and benzyl alcohol.

Although the sediment in the lagoon is very nonhomogenous, and it is possible that the unstabilized sediment sample happened to contain fewer organics than the samples that were stabilized, precautions were taken to assure that all of the sediment samples were the same. These precautions included thoroughly mixing the original sediment sample before separating it into the various samples to undergo stabilization and testing. Assuming that all of the sediment samples were about the same before stabilization, it appears as though the stabilization procedure tested either allows organics to leach more easily from the sediment or adds organics to the sediment that can then leach out. Therefore, based on the analytical results from this Treatability Study, it is determined that stabilization of the sediment with insitu disposal is not a viable alternative for the BROS Site since the tested stabilization procedure appears to cause an increase in the leaching of organic contaminants.

### A.3 Incineration

Since incineration seems to be the most likely method of lagoon oil and sediment disposal, this method was given the most consideration in this Treatability Study. The following subsections present information concerning those identified high-temperature incinerators that may be capable of disposing of the lagoon oil and/or sediment.

- At-Sea-Incineration, Inc. (ASI)

ASI plans to incinerate organic liquids, including PCB-contaminated liquids, aboard specially designed ocean-going incinerator vessels. Although ASI is currently in the process of securing the necessary permits to become fully operational, one or two test burns (1.3 million gallons each) are planned for 1984-1985. ASI uses liquid injection incinerators on its vessels. This type of incinerator can only incinerate liquids and has a low tolerance for suspended solids. ASI is currently using Philadelphia, Pennsylvania, as its terminal facility, although a permanent terminal facility in the Newark, New Jersey, area is planned for the future.

- Chemical Waste Management, Inc. (CWM)

CWM plans to incinerate organic liquids, including PCB contaminated liquids, aboard specially designed incineration vessels similar to those owned by ASI. CWM does not have the necessary permits in place at the time of this writing (July 1984) to incinerate wastes generated in the United States, although CWM has been incinerating organic liquids generated abroad. The CWM vessel uses liquid injection incinerators, which can only handle liquids and which have a low tolerance for suspended solids. Once the necessary permits are secured, CWM is expected to use some port on the Gulf Coast as its terminal facility.

- Energy Systems Company (ENSCO)

ENSCO offers two PCB-contaminated waste disposal options. The first is its permanent incineration facility, located in El Dorado, Arkansas. This facility is licensed to handle PCB-materials, and, since it is a rotary kiln incinerator, can incinerate liquid and nonliquid materials.

The second option available from ENSCO comes from its subsidiary, Pyrotech Systems, Inc. Pyrotech owns and operates mobile rotary kiln incinerators that are licensed to incinerate PCB materials. These mobile incinerators are truck-mounted and include on-board laboratory facilities for all necessary analyses. Since these mobile units use rotary kiln incinerators, they are capable of incinerating liquid and solid materials.

- Rollins Environmental Services, Inc. (Rollins)

Rollins presently owns and operates a rotary kiln incinerator at its facility in Deer Park, Texas. This facility is licensed to incinerate PCB waste, and, since it is a rotary kiln incinerator, can handle liquid and nonliquid materials. Rollins also owns and operates an incinerator facility in Bridgeport, New Jersey, located less than 10 miles from the BROS Site. Although the Rollins Bridgeport incinerator is reported to be exactly the same as the Deer Park facility, the Bridgeport incinerator has not yet been licensed to incinerate wastes containing greater than 50 ppm PCB. Rollins is attempting to license the Bridgeport incinerator for PCB materials, but it is unknown whether and when such licensing will be granted.

- SCA Services (SCA)

SCA has recently obtained the necessary permits to incinerate PCB materials at their facility located near Chicago, Illinois. This incinerator

is a rotary kiln type and can, therefore, handle liquid and nonliquid wastes.

- General Electric (GE)

GE operates a PCB waste incinerator in Pittsfield, Massachusetts. This incinerator is of the liquid injection type and was specifically designed for the incineration of transformer oils and similar liquids with high concentrations of PCBs. The GE incinerator can only handle liquids and has a very low tolerance for suspended solids.

In addition to the above-mentioned commercial incinerators, the EPA operates a mobile, rotary kiln incinerator. The EPA incinerator has received its TSCA permit for the incineration of liquids containing up to 40 percent PCB and is in the process of securing a permit to incinerate PCB solids as well. However, the EPA mobile incinerator is presently used for small cleanup jobs and may not be available for a long-term commitment, as would be necessary for the BROS Site.

#### A.4 Treatability Analyses

In order to determine whether any of the previously mentioned incinerator facilities were capable of disposing of the lagoon liquid and/or sediment, and in order to develop reliable disposal cost estimates, samples of the oil and sediment were sent to each of the commercial incinerator facilities mentioned (with the exception of the GE facility, which was determined to be unsuitable because of the high solids content of the BROS lagoon oil and sediment). In addition, samples were sent to CECOS International for evaluation of landfilling (CWM also evaluated the landfill option), and to Velsicol Chemical Corporation for stabilization/fixation analysis, as previously mentioned.

The samples that were used for the Treatability Study were collected from the BROS lagoon on January 11, 1984, by personnel from EMPAK, Inc., with oversight provided by NUS personnel.

Of the samples that were sent to prospective disposers, the following laboratories provided analytical support: RECRA Research, Inc. (associated with CECOS International); ENTEK Laboratories (associated with ENSCO); and an unknown laboratory subcontracted by At-Sea-Incineration, Inc. In addition, samples of the oil and sediment were sent to the NUS laboratory for analysis of the so-called "incineration parameters." The results of these analyses are summarized in Tables A-2 and A-3. Table A-2 presents the results for the lagoon oil; Table A-3 presents the results for the lagoon sediment.

An important point that should be noted concerns the PCB analyses of the oil and sediment from the Treatability Study. The PCB content of the lagoon oil appears somewhat consistent with the NUS Remedial Investigation results, and it seems safe to assume that the oil contains greater than 500 ppm PCB. However, in three of the four analyses of the lagoon sediment, the PCB levels were low, whereas in the fourth sediment sample the PCB concentration was exceptionally high. This wide variation in the PCB content of similar samples (the sediment collected for the Treatability Study was homogenized before repackaging and shipping to the potential disposers) could be the result of different analytical techniques being used by different labs, or the sediment being extremely nonhomogeneous in its PCB distribution, even when thoroughly mixed. Nevertheless, the original assumption that the sediment contains greater than 500 ppm PCB (based on the Remedial Investigation results) may need re-evaluation. If it can be assumed that the sediment contains less than 500 ppm PCB (or possibly less than 50 ppm PCB), then the available disposal options for the sediment would become somewhat more diverse. Also, if it can be assumed that the sediment contains less than 500 ppm PCB (while it is still assumed that the oil contains greater than 500 ppm PCB), then the question as to whether the oil should be removed before the water level of the lagoon is lowered or after the lagoon level is lowered becomes a critical concern. In other words, if the lagoon level is dropped while the oil is still in place, then the oil may coat the lagoon sediment, and thus qualify the lagoon sediment as containing greater than 500 ppm PCB. On the other hand, if the oil is removed before the lagoon level is lowered, then the lagoon sediment could possibly be

TABLE A-2

**SUMMARY OF ANALYSES FROM TREATABILITY STUDY  
LAGOON OIL PHASE  
BRIDGEPORT RENTAL AND OIL SERVICES SITE**

Parameter	Laboratory			
	NUS	RECRA Research	ENTEK Labs	At-Sea- Incineration
Total PCB (µg/g)	820	690	882	105
Organic Halides (µg/g)	2.5	- <sup>3</sup>	-	-
Chlorine (µg/g)	-	<1000	1393	3300
Ash (%)	1.1	-	1.48	2.7
Heat Value (BTU/lb)	WNC	10,450	8,482	9,818
Flash Point <sup>1</sup> (°F)	<140	<180	-	<210
Moisture (%)	28.6	-	-	48
pH	4.7	-	5.0	4.35
Phosphorus (mg/kg)	13	-	-	-
Specific Gravity (g/ml)	0.945	0.95	0.80	0.954
Sulfur (%)	<0.05	-	-	0.28
Viscosity	13,700 <sup>2</sup>	Med-High	-	40,679 <sup>4</sup>
Arsenic (mg/kg)	0.1	-	-	0.4
Barium (mg/kg)	40	-	-	181
Cadmium (mg/kg)	<0.1	-	-	1.0
Chromium (mg/kg)	2.0	-	-	29
Copper (mg/kg)	10	-	-	19
Lead (mg/kg)	160	-	-	1525
Mercury (mg/kg)	<0.15	-	-	0.25
Nickel (mg/kg)	1.0	-	-	6.0
Selenium (mg/kg)	<0.1	-	-	0.05
Silicon (mg/kg)	16,000	-	-	-
Silver (mg/kg)	<0.3	-	-	0.2
Thallium (mg/kg)	<2.5	-	-	2.0
Zinc (mg/kg)	15	-	-	66
Titanium (mg/kg)	<13	-	-	-
Sodium (mg/kg)	30	-	-	-

<sup>1</sup>Penske-Marten Closed Cup

<sup>2</sup>Centipoise

<sup>3</sup>Dash (-) indicates analysis not performed

<sup>4</sup>Saybolt Universal seconds @ 70°F

WNC = Will Not Combust

Source: Compilation by NUS Corporation, Pittsburgh, Pennsylvania, April 1984

TABLE A-3

**SUMMARY OF ANALYSES FROM TREATABILITY STUDY  
LAGOON SEDIMENT PHASE  
BRIDGEPORT RENTAL AND OIL SERVICES SITE**

Parameter	Laboratory			
	NUS	RECRA Research	ENTEK Labs	At-Sea- Incineration
Total PCB (µg/g)	14	18.5	2010	7.5
Organic Halides (µg/g)	1.4	-	-	-
Chlorine (µg/g)	-	<1000	-	-
Ash (%)	66.9	-	65.4	75.1
Heat Value (BTU/lb)	WNC	1270	-	-
Flash Point <sup>1</sup> (°F)	<140	<180	-	-
Moisture (%)	27.6	-	-	-
pH	6.7	-	6.0	-
Phosphorus (mg/kg)	0.58	-	-	-
Specific Gravity (g/ml)	1.77	1.2	1.46	1.65
Sulfur (%)	<0.05	-	-	-
Viscosity	54,000 <sup>2</sup>	High	-	127,060 <sup>4</sup>
Arsenic (mg/kg)	7.6	0.53	-	-
Barium (mg/kg)	95	-	-	-
Cadmium (mg/kg)	0.65	0.45	-	-
Chromium (mg/kg)	12	25	-	-
Copper (mg/kg)	8.2	12	-	-
Lead (mg/kg)	760	368	-	-
Mercury (mg/kg)	0.1	0.03	-	-
Nickel (mg/kg)	9.2	31	-	-
Selenium (mg/kg)	0.25	<0.05	-	-
Silicon (mg/kg)	320,000	-	-	-
Silver (mg/kg)	<0.3	0.35	-	-
Thallium (mg/kg)	4.0	0.82	-	-
Zinc (mg/kg)	32	95	-	-
Titanium (mg/kg)	<13	-	-	-
Sodium (mg/kg)	290	-	-	-
Antimony (mg/kg)	-	0.59	-	-
Beryllium (mg/kg)	-	0.44	-	-

<sup>1</sup>Penske-Marten Closed Cup

<sup>2</sup>Centipoise

<sup>3</sup>Dash (-) indicates analysis not performed

<sup>4</sup>Saybolt Universal seconds @ 70°F

WNC = Will Not Combust

Source: Compilation by NUS Corporation, Pittsburgh, Pennsylvania, April 1984

treated as containing less than 500 ppm PCB, in which case it could conceivably be stabilized in place or disposed of in an approved chemical waste landfill (resulting in substantial savings in disposal costs).

#### A.5 Incinerator Responses

Of the previously identified incinerators the following responses were received concerning disposal of the lagoon oil and/or sediment.

- ASI

The lagoon sediment is definitely unsuitable for ASI's ocean-going incineration vessel. (The sediment is far too high in solids.)

The lagoon oil is acceptable; however, the oil would need to be blended with other, "thinner" solvents to reduce its viscosity. One potential problem is the high lead content of the oil observed by ASI (1525 ppm Pb). ASI's limit on lead is 100 ppm. ASI is permitted to blend wastes to strive for an overall lead content of 100 ppm; however, if 1525 ppm Pb is truly representative, then ASI feels that far too much dilution and blending would be required. (The NUS laboratory detected only 160 ppm Pb in the lagoon oil, a Pb level which is acceptable to ASI).

ASI cost estimate for incineration of lagoon oil (not including transportation):

Cost: \$0.32/lb. of oil

- CWM - No response on incineration of lagoon oil or sediment.

- ENSCO

ENSCO gave preliminary acceptance of the lagoon oil and the lagoon sediment for incineration using either the permanent facility in El Dorado, Arkansas, or using the Pyrotech mobile incinerator. If the mobile incinerator is used, then a permit from the State of New Jersey would be required. Acquiring this permit may be difficult and would depend upon the sentiments of the State of New Jersey. The necessary State permit is reportedly similar to a TSCA Part A and Part B permit, and the time necessary to secure this permit, assuming a favorable State attitude, is expected to be about one year.

ENSCO cost estimate for incineration at the El Dorado, Arkansas, facility (not including transportation of the waste or disposal of the residual ash):

Cost:   \$0.20/ lb of oil  
          \$0.50/lb of sediment

ENSCO cost estimate for onsite incineration using the Pyrotech mobile incinerator (not including any site work, such as excavation of the sediment or collection of the oil, or disposal of any residual ash):

Cost:   \$0.10/lb of oil  
          \$0.10/lb of sediment

- Rollins - No response on incineration of lagoon oil or sediment.
- SCA

SCA gave preliminary acceptance of the lagoon oil and lagoon sediment for incineration at the Chicago facility.

SCA cost estimate for incineration of the lagoon oil and sediment (the cost does not include transportation of the waste, but does include disposal of all residual ash at SCA's hazardous waste landfill in Fort Wayne, Indiana):

Cost:     \$0.27/lb of oil  
           \$0.61/lb of sediment

One point that came across very clearly in all correspondence with prospective waste disposers was that since January 1, 1984, all licensed PCB incinerators have been swamped with incineration requests because of changes in the regulations for storage of PCB articles. Therefore, if offsite incineration is to be used as the method of disposal for the lagoon oil and/or sediment, then requests to the selected incineration facility(s) should be made as far in advance as possible to ensure that the incinerator has the available capacity at the time shipment is anticipated, especially for the quantities of PCB waste that are present at the BROS Site. Likewise, if onsite incineration is to be used, then plans should be made well in advance since the permitting process may take a year or more.

#### **A.6 Further Development of Disposal Costs**

As is evident in the previous discussion of responses from prospective disposers, the cost estimates provided are difficult to compare because some facilities are much nearer to the site than others and because some estimates include additional services (such as residual ash disposal) while other estimates do not. In order to provide a consistent basis for the various disposal alternatives to be evaluated, a more detailed cost estimate for lagoon waste disposal will be developed in this section. The bases and assumptions that are used to develop these cost estimates are presented below:

- All cost estimates are developed on a "per pound of starting material" basis.

- Cost estimates will not include any site work, such as sediment excavation, oil collection, etc. Site work is included elsewhere in this report as a separate cost item.
- Cost estimates for disposal are based on the waste's having been already removed from the lagoon and placed in a temporary storage tank or bin. The cost estimates presented here include the cost to pump or convey the waste from the temporary storage container to the onsite incinerator or to haul the waste to its offsite point of disposal. The cost of the temporary storage containers is not included in this estimate. Also included is the cost for transportation and disposal of any residual ash (from incineration) at an approved chemical waste landfill. In the case of direct landfilling of the lagoon sediment, the cost for appropriate stabilization of the sediment is included. For stabilizing and landfilling the sediment, it is assumed that the sediment will be determined to fall into the 50 to 500 ppm PCB category, and that the stabilized sediment will have a load-bearing capacity of 150 pounds per square foot.
- The heat of combustion of the lagoon oil is 10,000 BTU/lb; the heat of combustion of the sediment is 1,000 BTU/lb.
- The ash content of the oil is two percent; the ash content of the sediment is 70 percent.
- The sediment is a pumpable material and therefore can be hauled in bulk to an offsite incinerator. (If the sediment is not pumpable, then it would require packaging in incinerable drums before being hauled to an offsite incinerator).
- Hauling cost estimates are based on 40,000 pound loads at \$5.00 per loaded mile.

**A.6.1 ASI – Incineration Aboard Ocean-Going Vessel**Oil Phase

- Hauling

Bridgeport to Philadelphia ≈ 20 miles

$$\frac{20 \text{ miles/load} \times \$5.00/\text{mile}}{40,000 \text{ lbs/load}} = \$0.0025/\text{lb. oil}$$

- Incineration (assuming Pb levels are acceptable)

$$\text{Incineration cost (supplied by ASI)} = \$0.320/\text{lb. oil}$$

**Disposal Cost for Oil at ASI**

$$\text{Hauling} + \text{incineration} + 20\% \text{ contingency} = \$0.386/\text{lb. oil}$$

Sediment Phase

Unacceptable for disposal at ASI

**A.6.2 ENSCO – Incineration at El Dorado, Arkansas**Oil Phase

- Hauling

Bridgeport to El Dorado = 1,300 miles

$$\frac{1,300 \text{ miles/load} \times \$5.00/\text{mile}}{40,000 \text{ lb./load}} = \$0.162/\text{lb. oil}$$

- Incineration

Incineration cost (supplied by ENSCO ) = **\$0.200/lb. oil**

- Ash disposal at CWM chemical waste landfill in Emelle, Alabama

- hauling

El Dorado, Arkansas to Emelle, Alabama = 300 miles

$$\frac{300 \text{ miles/load} \times \$5.00/\text{mile}}{40,000 \text{ lb./load}} = \$0.0375/\text{lb. ash}$$

- Disposal

Disposal cost (supplied by CWM, including applicable State and Federal taxes) = \$73/ton = \$0.036/lb.

- Total - ash disposal

Hauling and disposal fee = \$0.0735/lb. ash

$$\$0.0735/\text{lb. ash} \times 0.02 \text{ lb. ash/lb. oil} = \textbf{\$0.0015/lb. oil}$$

**Disposal Cost for Oil at El Dorado**

**Hauling + incineration + ash disposal + 20% contingency = \$0.437/lb oil**

**Sediment Phase**

- Hauling (see oil phase cost development for detail)

Hauling cost (assuming pumpable) = **\$0.162/lb. sediment**

- Incineration

Incineration cost (supplied by ENSCO) = **\$0.500/lb. sediment**

- Ash Disposal (see oil phase cost development for detail)

Ash Disposal cost = \$0.0735/lb ash x 0.7 lb. ash/lb sediment =  
**0.052/lb. sediment**

**Disposal Cost for Sediment at El Dorado**

**Hauling + incineration + ash disposal + 20% contingency = \$0.857/lb. sediment**

**A.6.3 ENSCO/Pyrotech - Onsite Incineration**

**Oil Phase**

- Incineration

Incineration cost (provided by Pyrotech) = **0.110/lb. oil**

Includes continuous stack monitoring, firing fuel, offgas scrubber operation, and disposal of scrubber effluent.

- Ash Disposal (at CECOS Niagara Falls)
  - Hauling (see A.6.5 for detail) = \$0.05/lb. ash
  - Disposal Fee (see A.6.5 for detail) = \$0.0475/lb. ash
  - Total Ash Disposal Cost

Hauling and Disposal Fee = \$0.0975/lb. ash

\$0.0975/lb ash x 0.02 lb. ash/lb oil = **\$0.002/lb. oil**

**Disposal Cost for Oil – Onsite Incineration**

Incineration + Ash Disposal + 20% contingency = **\$0.134/lb oil**

**Sediment Phase**

- Incineration

Incineration cost (provided by Pyrotech) = **\$0.110/lb. sediment**

Includes continuous stack monitoring, firing fuel (assuming sediment incineration can be coordinated with waste oil incineration), offgas scrubber operation, disposal of scrubber effluent.

- Ash Disposal (at CECOS Niagara Falls)

- Hauling cost = \$0.05/lb. ash

- Disposal Fee = \$0.0475/lb. ash

- Total Ash Disposal Cost

Hauling and Disposal Fee = \$0.0975/lb. ash

\$0.0975/lb. ash x 0.7 lb. ash/lb. sediment = **\$0.0682/lb. sediment**

**Disposal Cost for Sediment-Onsite Incineration**

Incineration + Ash Disposal + 20% contingency = **\$0.214/lb. sediment**

**A.6.4 SCA - Incineration at Chicago, Illinois****Oil Phase**

- Hauling

Bridgeport to Chicago = 800 miles

$\frac{800 \text{ miles/load} \times \$5.00/\text{mile}}{40,000 \text{ lb/load}} =$  **\$0.100/lb. oil**

- Incineration (including ash disposal)

Incineration Cost (supplied by SCA) = **\$0.270/lb. oil**

**Disposal Cost for Oil at SCA**

Hauling + incineration + 20% contingency = **\$0.444/lb. oil**

**Sediment Phase**

- Hauling (see oil phase cost development for detail)

Hauling Cost = **\$0.100/lb. sediment**

- Incineration (including ash disposal)

Incineration cost (supplied by SCA) = **\$0.610/lb. sediment**

**Disposal Cost for Sediment at SCA**

Hauling + Incineration + 20% contingency = **\$0.852/lb. sediment**

**A.6.5 CECOS International - Stabilization and Chemical Waste  
Landfilling at Niagara Falls, New York**

**Oil Phase**

Stabilization and chemical waste landfilling of the oil phase was not considered to be appropriate since the oil phase is a liquid that appears to contain greater than 500 ppm PCB.

**Sediment Phase**

- Stabilization (including labor, equipment, and materials)

Stabilization Cost (provided by Velsicol, Inc.) = **\$0.025/lb. sediment**

- Hauling

Bridgeport to Niagara Falls  $\approx$  400 miles

$$\frac{400 \text{ miles/load} \times \$5.00/\text{mile}}{40,000 \text{ lb./load}} = \$0.05/\text{lb. stabilized material}$$

Assuming 20 percent weight increase from stabilization process

Hauling cost =  $\$0.05/\text{lb stabilized} \times 1.2 \text{ lb. stabilized/lb. sediment} =$   
**\$0.060/lb. sediment**

- Disposal fee at CECOS - Niagara Falls

Disposal fee (including State and Federal taxes) = \$95/ton

\$95/ton stabilized = \$0.0475/lb. stabilized x 1.2 = **\$0.057/lb. sediment**

#### **Disposal Cost for Stabilized Sediment at CECOS - Niagara Falls**

**Stabilization + Hauling + Disposal Fee + 20% contingency = \$0.170/lb. sediment**

#### **A.6.6 CECOS International - Stabilization and Chemical Waste Landfilling at Cincinnati, Ohio**

##### **Oil Phase**

Stabilization and chemical waste landfilling of the oil phase was not considered to be appropriate since the oil phase is a liquid that appears to contain greater than 500 ppm PCB.

##### **Sediment Phase**

- Stabilization (including labor, equipment, and materials)

Stabilization cost (provided by Velsicol, Inc.) = **\$0.025/lb. sediment**

- Hauling

Bridgeport to Cincinnati ≈ 600 miles

$$\frac{600 \text{ miles/load} \times \$5.00/\text{mile}}{40,000 \text{ lb/load}} = \$0.075/\text{lb. stabilized}$$

Assuming 20 percent weight increase from stabilization process

Hauling cost = \$0.075/lb. stabilized x 1.2 = **0.090/lb. sediment**

- Disposal Fee at CECOS - Cincinnati

Disposal fee (including State and Federal taxes) = \$90/ton

\$90/ton stabilized = \$0.045/lb. stabilized x 1.2 = **\$0.054/lb. sediment**

**Disposal Cost for Stabilized Sediment at CECOS - Cincinnati**

**Stabilization + Hauling + Disposal Fee + 20% contingency = \$0.203/lb. sediment**

**A.6.7 CWM - Stabilization and Chemical Waste Landfilling  
at Emelle, Alabama**

Oil Phase

Stabilization and chemical waste landfilling of the oil phase was not considered to be appropriate since the oil phase is a liquid that appears to contain greater than 500 ppm PCB.

Sediment Phase

- Stabilization (including labor, equipment, and materials)

Stabilization cost (provided by Velsicol, Inc.) = **\$0.025/lb. sediment**

- Hauling

Bridgeport to Emelle, Alabama ≈ 1,000 miles

$$\frac{1,000 \text{ miles/load} \times \$5.00/\text{mile}}{40,000 \text{ lb/load}} = \$0.125/\text{lb. stabilized}$$

Assuming 20 percent weight increase from stabilization process

$$\$0.125 \text{ lb/stabilized} \times 1.2 = \$0.150/\text{lb. sediment}$$

- Disposal Fee

Disposal cost (including State and Federal Taxes) = \$73/ton

$$\$73/\text{ton stabilized} - \$0.0365/\text{lb. stabilized} \times 1.2 = \$0.0438/\text{lb. sediment}$$

**Disposal Cost for Stabilized Sediment at CWM – Emelle, Alabama**

$$\text{Stabilization} + \text{Hauling} + \text{Disposal Fee} + 20\% \text{ contingency} = \$0.263/\text{lb. sediment}$$

#### **A.7 Treatability Study Summary**

From this treatability study and from a review of applicable regulations, it is evident that only two disposal options are available for the oil: onsite incineration and offsite incineration. Three disposal options appear available for the lagoon sediment: onsite incineration, offsite incineration, and stabilization with offsite landfilling (stabilization and landfilling carry the caveat that the sediment contains less than 500 ppm PCB). The alternative of stabilizing the sediment and redisposing of it in the lagoon was eliminated from further consideration based on the analytical data of the leachability study which indicated that the stabilized sediment leached more organic contaminants than the unstabilized sediment. Furthermore, it is unlikely that State or Federal environmental regulatory agencies would approve of the onsite redisposal option, regardless of the results from the leachability study.

Following the identification of the applicable disposal options, cost estimates were solicited from the identified potential disposal firms. Using the estimates provided by some of the potential disposers, detailed disposal cost estimates were developed. A summary of these estimates is presented in Table A-4. From this cost development it is evident that the least expensive disposal option for the oil phase is onsite incineration. The costs for offsite oil incineration were roughly three times more expensive. Similarly, onsite incineration of the lagoon sediment is also the least expensive of the incineration options and is comparable in cost to the three stabilization and landfilling options. However, the "stabilization with landfilling" alternatives assume that the lagoon sediment falls into the 50 to 500 ppm PCB range; this assumption does not need to be made for the onsite incineration alternative.

The evaluation of lagoon remediation alternatives presented in Section 5 of this report uses the lowest cost disposal option for each of the identified disposal categories; that is, the onsite incineration cost for the oil and for the sediment is from the Pyrotech cost estimate (the only estimate available). The offsite oil incineration cost used in the evaluation is the ENSCO estimate, and the offsite sediment incineration cost is the SCA estimate. The cost used in the evaluation for the "sediment stabilization and offsite landfilling" option is from the CECOS-Niagara Falls estimate.

**TABLE A-4**

**DISPOSAL COST ESTIMATES FOR BROS  
LAGOON OIL AND SEDIMENT  
BRIDGEPORT RENTAL AND OIL SERVICES SITE**

<u>Disposal Firm</u>	<u>Disposal Method</u>	<u>Disposal Cost Estimate<sup>(1)</sup></u>	
		<u>Oil Phase</u>	<u>Sediment Phase</u>
At-Sea-Incineration, Inc.	Incineration at sea	\$0.386/lb.	Unacceptable
ENSCO	Incineration at El Dorado, Arkansas	\$0.437/lb.	\$0.857/lb.
SCA Services	Incineration at Chicago, Illinois	\$0.444/lb.	\$0.852/lb.
ENSCO/Pyrotech	Onsite incineration	\$0.134/lb.	\$0.214/lb.
CECOS International	Landfilling at Niagara Falls, New York	Unacceptable	\$0.170/lb. <sup>(2)</sup>
CECOS International	Landfilling at Cincinnati, Ohio	Unacceptable	\$0.203/lb. <sup>(2)</sup>
Chemical Waste Management, Inc.	Landfilling at Emelle, Alabama	Unacceptable	\$0.263/lb. <sup>(2)</sup>

(1) Disposal cost estimates include labor, equipment, materials, hauling, fees, and taxes associated with disposal; however, the costs for removal of the oil or sediment from the lagoon are not included.

(2) Assumes sediment contains between 50 and 500 ppm PCB; costs include onsite stabilization of the sediment.

Source: Compilation by NUS Corporation, Pittsburgh, Pennsylvania, April 1984.

## APPENDIX B

### B.1 Groundwater Modeling

#### B.1.1 Purpose

The purpose of simulating groundwater flow beneath the Bridgeport Rental and Oil Services Site is as follows:

- To estimate the permeability of the oily sludge on the sides and bottom of the lagoon
- To estimate the effects on contaminant plume migration of the following remedial action alternatives:
  - Lagoon Mounding - leave the existing lagoon, dikes, and groundwater mound in place.
  - Plume Dispersion - reduce the fluid level in the lagoon to the surrounding water table level, grade off dikes, and observe plume migration through dispersion.
  - Extraction Wells - pump several extraction wells and observe the effects on plume migration and concentration.
- To estimate the pumping rate that would be required to completely scavenge the contamination plumes.

#### B.1.2 Models

Two models were run on the unconfined Magothy-Raritan aquifer at the BROS Site. The Prickett-Lonquist Aquifer Simulation Model (PLASM) was used to

simulate the permeability of the oily sludge in the BROS lagoon. The Random Walk version of the Solute Transport and Dispersion Model (SOLUTE) by Prickett was used to simulate the effects of the remedial action alternatives described previously. The models were run on a COMPAQ portable microcomputer with MS-DOS in Microsoft BASIC.

PLASM is a two-dimensional, finite-difference model which solves matrices of input data consisting of head, transmissivity, and storage values. The model uses the Alternating Direction Implicit (ADI) method to solve a series of finite difference equations by Gaussian elimination. The finite difference equations are derivatives of the partial differential equation governing nonsteady, two dimensional flow of groundwater in an artesian, nonhomogeneous, isotropic aquifer.

SOLUTE is a two-dimensional finite-difference model which solves matrices of input data consisting of transmissivity, storage, dispersion, velocity and contaminant concentration values. The effects of advection, dispersion, and chemical reactions are included. The groundwater flow equation is solved in a manner similar to that used in PLASM. Dispersion of contaminants is simulated by applying scalar probability curves related to flow length and dispersion coefficients to input values of contaminant concentrations (Prickett, Naymik, and Lonquist, 1981).

### B.1.3 Input Data

The groundwater models were based on the following assumptions.

- Flow Model

The aquifer was modeled as two-dimensional, non-steady state, heterogeneous, and anisotropic with unconfined conditions. The transmissivity of the oily sludge in the lagoon was varied over several simulations in order to recreate the mounding effects of the lagoon.

Recharge boundaries (such as ponds) and groundwater mounding from topographic high points were also simulated.

- Transport Model

The transport model was a two-dimensional, homogeneous, and isotropic simulation under unconfined conditions. In order to simulate worst-case situations no retardation of contaminant migration was assumed to have occurred from interaction between the contaminant and the groundwater or aquifer. The concentration of chlorides in the monitoring wells were used to simulate contaminant dispersion at the beginning of the model.

The actual contaminants are mostly organic chemicals; therefore, some interaction may occur between the contaminants and the groundwater or aquifer.

#### B.1.3.1 Flow Model (PLASM)

Input data for the PLASM flow model consisted primarily of head, transmissivity, storage, and pumping values. The head data was taken from the elevations of the lagoon and surrounding ponds and swamps shown on the site topographic map. Since the aerial photography on which the topographic map was based was conducted prior to installation of NUS monitoring wells at the site, an exact match of head data between the lagoon and groundwater contours developed from the monitoring wells was not possible. The hydraulic gradient surrounding the site is relatively flat, and the default head was set to elevation 3.2 feet. The lagoon elevation was set to 14.1 feet.

Transmissivity and storage values were calculated from a pumping test of monitoring well S-3C conducted by NUS geologists in September 1983. The default transmissivity was input as 38,000 gpd/ft. The default storage was 0.014. Storage values were increased at the Gaventa and Swindell Ponds and along the berm of Route 130 to reflect recharge and constant head boundary conditions (Prickett,

1971). Discharge (pumping) values were set to zero throughout the entire simulation period of 1 year.

A 2-dimensional grid consisting of 11 columns and 11 rows spaced at 125 foot intervals was superimposed over the lagoon and surrounding aquifer. Values for head, storage, transmissivity, and discharge were provided for each node in the grid. The finite difference equations were then developed from the values at each grid node.

#### B.1.3.2 Transport Models (SOLUTE)

Basic transport coefficients such as transmissivity, storage, hydraulic conductivity, and groundwater velocity were calculated from the pumping test mentioned previously.

Transmissivity	= 38,000 gpd/ft
Storage (specific yield)	= 0.014
Hydraulic Conductivity	= 321 gpd/ft <sup>2</sup>
Groundwater Velocity	= 0.03 ft/day

The velocities and dispersion coefficients change with the hydraulic gradient. Thus, the groundwater velocity was a function of the hydraulic gradient between the lagoon surface and the surrounding water table in the Lagoon Mounding simulation and was increased to 0.13 ft/day.

The porosity of the sand aquifer was calculated as 0.38 from grain size analyses of samples collected during drilling of the monitoring wells. The longitudinal and transverse dispersivities were estimated from empirical values for sand aquifers with a porosity of 0.40 (Anderson, 1979). The retardation coefficient was set to 1 to reflect no chemical reaction between the contaminant and the groundwater or aquifer. This would simulate a worst-case situation.

Contaminant particles were placed at nodes in a 2-dimensional grid overlying the site. The distribution of contaminant particles reflects the concentration of chlorides in groundwater samples obtained from monitoring wells on the site. The number of particles at each node at the start of the simulation reflect the approximate chloride concentration in mg/l. The particle distribution is shown under "Particle Mapping" on the simulation output.

In the extraction well model, several combinations of well locations and pumping rates were simulated in order to obtain maximum efficiency in removing contaminants from the groundwater.

For the simulations involving no remedial action or reducing the lagoon level down to the surrounding water table, a two-dimensional grid consisting of seven rows and nine columns was superimposed over the site. The rows and columns were spaced at 500 foot intervals. The grid covered the lagoon, the Swindell and Gaventa ponds, Little Timber Creek and Cedar Creek swamps, and Little Timber Creek itself. Basic groundwater transport coefficients were input at each node in the grid, and these values were applied to the finite-difference equations.

For the extraction well simulation, a grid composed of 15 rows and 14 columns each spaced at 125-foot intervals was superimposed over the lagoon and groundwater contamination plumes. This smaller, finer grid was used to more accurately simulate the shapes and concentration gradients of the contamination plumes.

#### **B.1.4 Simulation Results**

##### **B.1.4.1 Flow Model (PLASM)**

The transmissivity of the oily sludge in the bottom of the lagoon was varied over several computer runs. The sludge required a simulated transmissivity of nearly zero and a storage (specific yield) of 0.00001 to maintain the existing hydrostatic head in the lagoon. An exact reproduction of the groundwater mound was not

possible since the aerial photograph, from which the topographic map was developed, was taken before water levels were measured in the monitoring wells.

The flow model indicates that the berm along Rt. 130 provides a recharge barrier north of the site which may retard contaminant plume migration in that direction.

#### **B.1.5 Solute Transport Models (SOLUTE)**

##### **B.1.5.1 Lagoon Mounding**

The results of the Lagoon Mounding simulation indicated that the contaminant plume migrated about 750 feet northeast into Little Timber Creek swamp and 500 feet west into the Gaventa orchard over a 10-year period. By 20 years, the plume had moved 1,500 feet northeast, as shown by a particle concentration of 1 (1 particle equals 10 mg/l). The plume dispersed below the 10 mg/l limit west of the lagoon after 20 years. By 30 years, the plume had advanced about 2,000 feet northeast into Little Timber Creek.

##### **B.1.5.2 Plume Dispersion**

This simulation involved removing the impounded liquids and surrounding dike, and simulating plume migration by dispersion with little or no advective transport because of the low hydraulic gradient. The 10 mg/l contaminant plume limit had dispersed 500 feet north, northeast and east after a 30-year simulation period. No dispersion above the 10 mg/l limit was observed south and west of the lagoon after 30 years.

##### **B.1.5.3 Extraction Wells**

Several configurations of monitoring wells and pumping rates were simulated to design the most efficient extraction well field. The best results were obtained when 32 extraction wells were pumped at 20 gpm each (640 gpm total) over a five-year period. The well field reduced the contaminant concentrations from greater

than 400 mg/l to background chloride concentrations (10-50 mg/l) over most of the grid. This was an 88 to 98 percent reduction in contaminant concentration. Isolated "patches" of remnant contamination remained northeast of NUS monitoring well cluster S-3 and east of cluster S-11. Significant concentrations of chlorides also migrated into Little Timber Creek Swamp east of the site during the simulation; however, no extraction wells were located in the swamp. The locations of the extraction wells and contaminant concentration contours are shown in Figures 3-4 and 3-5, in Section 3.2.2.

#### **B.1.6 Conclusions**

The flow model (PLASM) indicates that the permeability of the oily sludge in the BROS lagoon is very low, resulting in impounded liquids and occasional overflow into surrounding ponds and swamps. The highway berm along Rt. 130 north of the side provides a recharge barrier which may impede plume migration to the north.

The solute transport models (SOLUTE) indicate that reducing the liquid level in the lagoon and grading off the surrounding dikes will remove the mechanism of advective contaminant transport, and reduce the extent of plume migration from about 2,000 feet to 500 feet over a 30-year period. The extraction well field simulation indicated that pumping 32 wells at 20 gpm each (640 gpm total) will reduce chloride concentrations in the groundwater to background levels beneath most of the site in about five years.

**APPENDIX C**  
**COST ESTIMATE SHEETS**

# PRICING SHEET

PAGE NO. 1 OF 3 PAGES

NAME <b>BRIDGEPORT SITE</b>	ARCH. OR CONTRACTOR <b>NUS CORP. -- PEC DIV</b>	ESTIMATING <b>0707.22</b>
CATION <b>LOGAN TWP., N.J.</b>	TYPE OF WORK <b>LAGOON WATER TREATMENT PLANT</b>	
ESTIMATED BY <b>WPM</b>	PRICED BY <b>WPM</b>	EXTENDED BY <b>WPM</b>
	CHECKED BY <b>WPM</b>	DATE <b>4-26-84</b>

DESCRIPTION	QUAN.	"	"	EXTENSION
-------------	-------	---	---	-----------

## LAGOON WATER TREATMENT PLANT

### CAPITAL COST

1) 200-400 gpm TREATMENT PLANT (INCL. OIL SEPARATION, MIX + FLOC TANK, CLARIFIER, FILTER, CARBON ADSORBERS)	1			500000
				500000
20% CONTINGENCY				100000
				600000
10% OVERHEAD + PROFIT				60000
				660000
15% ENGINEERING				100000
TREATMENT PLANT COST				760000

C-1

TOTALS

# PRICING SHEET

PROJECT: BRIDGEPORT SITE  
 LOCATION: LOGAN TWP., N.J.  
 ESTIMATED BY: WPM  
 PRICED BY: WPM  
 EXTENDED BY:  
 ARCHITECT OR CONTRACTOR: NUS CORP. -- PEC DIV.  
 TYPE OF WORK: LAGOON WATER TREATMENT -- 44 MG  
 CHECKED BY: JDP/m  
 DATE: 4-26-84  
 PAGE NO. 2 OF 3 PAGES  
 ESTIMATE NO. 0707.22

DESCRIPTION	QUAN.		EXTENSION
<u>ON-SITE LAGOON WATER TREATMENT -- 44 MG</u>			
(44 MG IS BASED ON 20 MG OF RAINWATER ACCUMULATION OVER 3-4 YEARS, AND THREE LAGOON VOLUMES (BELOW THE WATER TABLE) AFTER EXCAVATING 40,000 yd <sup>3</sup> OF SEDIMENT (~15,000 yd <sup>3</sup> BELOW WATER TABLE) FOR A TOTAL OF 8 MG PER LAGOON VOLUME).			
<u>TREATMENT PLANT OPERATION</u>			
1) LAGOON WATER TREATMENT 44MG (200 gpm) 6 MONTHS OPERATION - 3 SHIFTS			
A) OPERATION - 3 OPER./SHIFT + SUPER.	50,000/yr	$\times 1.3 \text{ OPER.} \times \frac{6 \text{ MO.}}{\text{YR}}$	375000
B) MAINTENANCE	\$760,000 (CAP. INV.)	$\times 0.03$	22800
C) ENERGY	(90 HP $\times 0.7457 = 67 \text{ KW/hr}$ )	$\times 24 \text{ hr.} \times 180 \times 0.065$	18800
D) CHEMICAL (USAGE RATES FROM ETAPAK)			
1) NaOH	3.7 TON	295	1100
2) POLYMER	1,100 LB	350	3850
3) Fe Cl <sub>3</sub>	37 TON	720	26700
4) ACT. CARBON	111 TON	1800	200000
E) SLUDGE REMOVAL			
1) SOLIDIFICATION (59 gpm UNOCCUPIED FLOW)	1,100,000 gal	0.35	385000
2) HAULING (ASSUME HAZ)	108,800 mi	5	544000
20 yd <sup>3</sup> LOS., 400 MI., 272 loads			
3) DISPOSAL (CROOS-NIAG. FALLS)	9600 TONS	95	912000
			2,439,000
		20% CONTINGENCY	488,000
			2,927,000
		10% OVERHEAD + PROFIT	293,000
			3,220,000
		ENGINEERING	100,000
			3,320,000
		CAPITAL INVESTMENT (SEE P. C-1)	760,000
			4,080,000
		C-2	
TOTALS			

# PRICING SHEET

NAME <b>BRIDGEPORT SITE</b>	ARCH OR CONTRACTOR <b>NHS CORP. -- REC DIV</b>	PAGE NO. <b>3</b> OF <b>3</b> PAGES
LOCATION <b>LOGAN TWP., N.J.</b>	TYPE OF WORK <b>LAGOON WATER TREATMENT -- 95 MG</b>	ESTIMATE NO. <b>0707.22</b>
ESTIMATED BY <b>WPM</b>	PRICED BY <b>WPM</b>	EXTENDED BY <b>WPM</b>
	CHECKED BY <b>WPM</b>	DATE <b>4-26-84</b>

DESCRIPTION	QUAN.	UNIT	EXTENSION
<u>ONSITE LAGOON WATER TREATMENT -- 95 MG</u>			
(95 MG IS BASED ON 40 MG OF RAINWATER ACCUMULATION OVER 3-4 YRS, AND FIVE LAGOON VOLUMES (BELOW WATER TABLE) AFTER EXCAVATING 80,000 YD <sup>3</sup> OF SEDIMENT (~30,000 YD <sup>3</sup> BELOW WATER TABLE) FOR A TOTAL OF 19 MG PER LAGOON VOLUME)			

## TREATMENT PLANT OPERATION

1) LAGOON WATER TREATMENT	95 MG (200 gpm)	12 MONTHS OPER.	3 SHIFTS	
A) OPERATION - 3 OPER/SHIFT + SUPER	\$50,000/yr	x 13.0 PER	=	650,000 <sup>00</sup>
B) MAINTENANCE	\$760,000 (CAP. INV.)	x 0.03		22,800 <sup>00</sup>
C) ENERGY	(90 HP x 0.746 = 67 KW/HR)	x 24 x 365 x 0.065		38,200 <sup>00</sup>
D) CHEMICAL				
1) NaOH	8.0 TON	295 <sup>00</sup>		2,400 <sup>00</sup>
2) POLYMER	240 LB	35 <sup>00</sup>		8,400 <sup>00</sup>
3) FeCl <sub>3</sub>	80 TON	720 <sup>00</sup>		57,600 <sup>00</sup>
4) ACT. CARBON	240 TON	180 <sup>00</sup>		43,200 <sup>00</sup>
E) SLUDGE REMOVAL				
1) SOLIDIFICATION (Sediment UNDERFLOW)	2.38 MG	0.35		833,000 <sup>00</sup>
2) HAULING (ASSUME HAZ)	236,000 LB	5 <sup>00</sup>		1,180,000 <sup>00</sup>
20 YD <sup>3</sup> SLUDGE, 400 MI, 590 LBS/CL				
3) DISPOSAL	21,000 TONS	95 <sup>00</sup>		1,995,000 <sup>00</sup>
				5,219,400 <sup>00</sup>
			20% CONTINGENCY	1,043,900 <sup>00</sup>
				6,263,300 <sup>00</sup>
			10% OVERHEAD + PROFIT	626,300 <sup>00</sup>
				6,889,600 <sup>00</sup>
			ENGINEERING	113,000 <sup>00</sup>
				7,002,600 <sup>00</sup>
			CAPITAL INVESTMENT (SEE P. C-1)	760,000 <sup>00</sup>
				\$7,762,600 <sup>00</sup>

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TOTALS

# PRICING SHEET

PAGE NO. 1 OF 2 PAGES

NAME BRIDGEPORT SITE  
 LOCATION 106AN ZWP, N.J.  
 PREPARED BY WPM  
 PRICED BY WPM

ARCH OR CONTRACTOR NUS CORP. -- PER DIV.  
 TYPE OF WORK WATER TREATMENT - Dupont-44MG  
 CHECKED BY 1/12/84  
 DATE 4-26-84  
 ESTIMATE NO 0707.22

EXTENDED BY

DESCRIPTION

QUAN.

ft

M

L

M+L

EXTENSION

WATER TREATMENT AT Dupont - 44 MG

1) 50000 gal HOLDING TANK	1		10000 <sup>ft</sup>	2000 <sup>ft</sup>	12000 <sup>ft</sup>
2) OIL/WATER SEPARATOR (500gpm)	1		35000 <sup>ft</sup>	6000 <sup>ft</sup>	41000 <sup>ft</sup>
3) 500 gpm PUMP	2	5000 <sup>ft</sup>	10000 <sup>ft</sup>	16000 <sup>ft</sup>	11600 <sup>ft</sup>
4) PIPING	200 FT	40 <sup>ft</sup> /ft	INSTALLED		8000 <sup>ft</sup>
5) LABOR - 3 OPERATORS	3	25000 <sup>ft</sup>		75000 <sup>ft</sup>	75000 <sup>ft</sup>
10 hr/day, 5-6 days/wk					
6 MO. @ 50,000/yr					

6) HAULING 20 mi, 5000 gal/haul, 176,000 gal	5 <sup>ft</sup>				880000 <sup>ft</sup>
8,800 loads, 5/mile					

7) TREATMENT @ Dupont	44 MG	D10/gal			4,400,000 <sup>ft</sup>
(BALLPARK COST PROVIDED BY Dupont)					

				5,427,600 <sup>ft</sup>
10% CONTINGENCY				1,085,500 <sup>ft</sup>
				6,513,100 <sup>ft</sup>
10% OVERHEAD + PROFIT				651,300 <sup>ft</sup>
				7,164,400 <sup>ft</sup>
ENGINEERING				50,000 <sup>ft</sup>
				7,214,400 <sup>ft</sup>

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TOTALS

# PRICING SHEET

PAGE NO. 2 OF 2 PAGES

BRIDGEPORT SITE  
LOGAN TWP., N.J.  
WPM WPM

ARCH OR CONTRACTOR  
NHS CORP -- PET DIV  
TYPE OF WORK  
WATER TREATMENT - DUPONT - 95 MG  
CHECKED BY  
WPM  
DATE  
4-26-84  
ESTIMATE NO  
0707.22

DESCRIPTION	QUAN.	a	M	L	M+L	EXTENSION
<u>WATER TREATMENT DUPONT - 95 MG</u>						
1) 50,000 gal HOLDING TANK	1		10000 <sup>00</sup>	2000 <sup>00</sup>	12000 <sup>00</sup>	
2) OIL/WATER SEPARATOR (500 gpm)	1		35000 <sup>00</sup>	6000 <sup>00</sup>	41000 <sup>00</sup>	
3) 500 gpm PUMP	2	5000 <sup>00</sup>	10000 <sup>00</sup>	1600 <sup>00</sup>	11600 <sup>00</sup>	
4) PIPING 200 FT. 40/FT. INSTALLED					8000 <sup>00</sup>	
5) LABOR - 3 OPERATORS 10 hr/day, 5-6 days/week 1 year @ 50,000 <sup>00</sup>	3	50000 <sup>00</sup>		150000 <sup>00</sup>	150000 <sup>00</sup>	
6) HAULING 20 mi. 500 gal./load 19,000 loads @ 5/mile	350,000 mi	5 <sup>00</sup>			1,750,000 <sup>00</sup>	
7) TREATMENT @ DUPONT (CALL PARK POST PROVIDED BY DUPONT)	95 MG	0.10			9,500,000 <sup>00</sup>	
					11,622,600 <sup>00</sup>	
			20% CONTINGENCY		2,324,400 <sup>00</sup>	
					13,947,000 <sup>00</sup>	
			16% OVERHEAD + PROFIT		1,395,000 <sup>00</sup>	
					15,342,000 <sup>00</sup>	
			ENGINEERING		7500 <sup>00</sup>	
					15,417,000 <sup>00</sup>	
			C-5			
TOTALS						

# PRICING SHEET

PAGE NO. 1 OF 3 PAGES

LOCATION <b>BRIDGEPORT SITE LOGAN TWP., N.J.</b>	ARCH. OR CONTRACTOR <b>NHS CORP. -- REC DIV.</b>	ESTIMATE NO. <b>0707.22</b>
ESTIMATED BY <b>AMF</b>	PRICED BY <b>AMF</b>	EXTENDED BY <b>AMF</b>
TYPE OF WORK <b>LAGOON OIL REMOVAL - EQUIPMENT</b>		CHECKED BY <b>JPM</b>
		DATE <b>4-13-84</b>

DESCRIPTION	QUAN.	M	L	M+L	EXTENSION
<u>LAGOON OIL - REMOVAL EQUIPMENT - PUMPING</u>					
1) SURFACE OIL SKIMMER WITH PUMP, 200' HOSE, 40 gpm	2	10,000 <sup>00</sup>	20,000 <sup>00</sup>	20,000 <sup>00</sup>	22,000 <sup>00</sup>
2) FLOATING OIL BAFLE 800' LONG, WITH 4' SKIRT, COLLAR, HARDWARE	1	11,000 <sup>00</sup>	11,000 <sup>00</sup>	1,000 <sup>00</sup>	12,000 <sup>00</sup>
3) OIL WATER SEPARATOR 40 gpm	1	15,000 <sup>00</sup>	15,000 <sup>00</sup>	5,000 <sup>00</sup>	20,000 <sup>00</sup>
4) OIL HOLDING TANK WITH POLY LINER, 50,000 gal	1	10,000 <sup>00</sup>	10,000 <sup>00</sup>	1,200 <sup>00</sup>	11,200 <sup>00</sup>
5) OIL & WATER PIPING - 6" (INSTALLED)	400'	60 <sup>00</sup>	16,000 <sup>00</sup>	8,000 <sup>00</sup>	24,000 <sup>00</sup>
6) ELECTRICAL STARTERS, CABLE, CONTROLS			2,000 <sup>00</sup>	2,000 <sup>00</sup>	4,000 <sup>00</sup>
SUBTOTALS			74,000 <sup>00</sup>	19,200 <sup>00</sup>	93,200 <sup>00</sup>
C-6					
TOTALS					

PAGE NO 2 OF 3 PAGES

## DECLARATION

ESTIMATED BY

PRICED BY

EXTENDED BY

CHECKED BY

DATE

ESTIMATE NO

**PAGES**

ARCH OR CONTRACTOR

NUS CORP. - PEC DIV. 0707.22  
TYPE OF WORK  
LAGOON OIL REMOVAL - 2MB - PUMPING

TYPE OF WORK

LAGOON OIL REMOVAL - DM6 - PUMPING.

WPMT

4-25-84

DESCRIPTION	QUAN.	M	L	M+L	EXTENSION
<u>LAGOON OIL REMOVAL - ZMC - PUMPING</u>					
1 TRUCK FROM PREVIOUS ESTIMATE FOR LAGOON OIL REMOVAL EQUIPMENT (PAGE C-6)		74000 <sup>00</sup>	17,200 <sup>00</sup>	93,200 <sup>00</sup>	
7) OPERATION - 3 per/SHIFT, 1 SHIFT/DAY, 5 DAYS/WEEK 25 WEEKS		$\$56,000/\text{yr} \times 3 \times \frac{25\text{WK}}{52\text{WK}} =$	72,115 <sup>00</sup>	72,115 <sup>00</sup>	
SUBTOTALS		74000 <sup>00</sup>	91,315 <sup>00</sup>	165,315 <sup>00</sup>	
LEVEL "C" WORKING CONDITIONS (70% MARKUP ON LABOR) $91,315 \times 0.7 =$				63,920 <sup>00</sup>	
			SUBTOTAL	229,235 <sup>00</sup>	
			20% CONTINGENCY	45,845 <sup>00</sup>	
				275,100 <sup>00</sup>	
			10% OVERHEAD & PROFIT	27,500 <sup>00</sup>	
				302,600 <sup>00</sup>	
			15% ENGINEERING	45,400 <sup>00</sup>	
			TOTAL	<u><u>348,000<sup>00</sup></u></u>	
			C-7		
TOTALS					

# PRICING SHEET

PAGE NO. 3 OF 3 PAGES

NAME <b>BRIDGEPORT SITE</b>	ARCH OR CONTRACTOR <b>NUS BRP -- PEC DIV.</b>	ESTIMATE NO. <b>0707.22</b>
LOCATION <b>LOGAN TWP., N.J.</b>	TYPE OF WORK <b>LAGOON OIL REMOVAL - 3 MG - PUMPING</b>	
PREPARED BY <b>HPM</b>	PRICED BY <b>HPM</b>	EXTENDED BY <b>WPM</b>
	CHECKED BY <b>WPM</b>	DATE <b>4-25-84</b>

DESCRIPTION	QUAN.	M	L	M+L	EXTENSION
<b>LAGOON OIL REMOVAL - 3 MG - PUMPING</b>					
1 THRU 6 FROM PREVIOUS ESTIMATE FOR LAGOON OIL REMOVAL EQUIPMENT (PAGE C-6)		74,000 <sup>00</sup>	19,200 <sup>00</sup>	93,200 <sup>00</sup>	
1) OPERATION - 3000R/SHIFT, 1 SHIFT/DAY, 5 DAYS/WK, 38 WEEKS $\$50,000/\text{yr} \times 3 \times \frac{38\text{WK}}{52\text{WK}} = 109,615^{00}$			109,615 <sup>00</sup>	109,615 <sup>00</sup>	
<b>SUBTOTALS</b>		74,000 <sup>00</sup>	129,815 <sup>00</sup>	203,815 <sup>00</sup>	
LEVEL "C" WORKING CONDITIONS 70% MARKUP ON LABOR $\$128,815 \times 0.7 =$				90,170 <sup>00</sup>	
				<b>SUBTOTAL</b> 293,985 <sup>00</sup>	
				20% CONTINGENCY 58,615 <sup>00</sup>	
				351,600 <sup>00</sup>	
				10% OVERHEAD & PROFIT 35,200 <sup>00</sup>	
				386,800 <sup>00</sup>	
				15% ENGINEERING 58,000 <sup>00</sup>	
				<b>TOTAL</b> 444,800 <sup>00</sup>	

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TOTALS

# PRICING SHEET

PAGE NO. 1 OF 1 PAGES

PROJECT <b>BRIDGEPORT ROS</b>		ARCH OR CONTRACTOR <b>NUS CORP. - PEC DIVISION</b>		ESTIMATE NO <b>0 707.22</b>
LOCATION <b>LOGAN TWP.</b>		TYPE OF WORK <b>SLUDGE REMOVAL AND DEWATERING - REVISION</b>		
ESTIMATED BY <b>WPM</b>	PRICED BY <b>WPM</b>	EXTENDED BY	CHECKED BY <b>WPM</b>	DATE <b>4-25-84</b>

DESCRIPTION	QUAN.	10	m	L	m : L	EXTENSION
<u>SLUDGE REMOVAL &amp; Dewatering - 40,000 yd<sup>3</sup></u>						
CONTAMINATED SLUDGE						
REMOVAL						
A. DRAGLINE	1		150000		150000	
B. MOBILIZATION	1			*30000	30000	
C. EXCAVATION	40,000 yd <sup>3</sup>	25.00		1000000	1000000	
2) LAGOON DEWATERING BINS						
100' L X 900' LG X 15' DP						
A) SHEET PILE	84,000 ft	9.10	336000	436800	772800	
B) GRAVEL 2' X 100' X 900'	6700 yd <sup>3</sup>		23450	20487	43937	
C) UNDERDRAIN PER. PIPE 4"	4500'		<del>2186</del>	2000	81186	
10"	1100'		4400	2815	7215	
			516036	1499102	2015138	2015138
LEVEL "C" WORKING CONDITION	1499102 x 0.7					1049371
						3064509
						20% CONTINGENCY
						612902
						3677411
						10% OVERHEAD AND PROFIT
						367741
						4045852
						10% ENGINEERING
						404515
						\$ 4449667
3) REMOVAL OF CONTAMINATED MATERIAL						\$ 76000
EAST OF LAGOON (SEE P. C-11)						
4) REMOVE, DECON., DISPOSE DEBRIS						\$ 166000
FROM LAGOON (SEE P. C-12)						
5) DRUM EXCAVATION & DISPOSAL (SEE P. C-13)						1,462,600
			C-9			
TOTALS						6,154,267

# PRICING SHEET.

PAGE NO 1 OF 1 PAGES

BRIDGEPORT ROS		ARCH. OR CONTRACTOR NUS CORP - PEC DIV		ESTIMATE NO 070722	
LOGAN TWP.		TYPE OF WORK SWAGE REMOVAL AND DENATURING - REVISION 2			
IMATED BY NPM	PRICED BY	EXTENDED BY	CHECKED BY NPM	DATE 4-25-81	

DESCRIPTION	QUAN.	UNIT	M	L	M & L	EXTENSION
<u>SLUDGE REMOVAL &amp; DEWATERING - 80,000 yd<sup>3</sup></u>						
1) CONTAMINATED SLUDGE REMOVAL						
A. DRAGLINE	1		150000		150000	
B. MOBILIZATION	1			30000	30000	
C. EXCAVATION	80,000 yd <sup>3</sup>	25.00		2,000,000	2000000	
2) LAGOON DEWATERING BINS						
100' X 1800' X 15' DP						
A) SHEET PILE	165,000 ft <sup>2</sup>	9.10	660000	858000	1518000	
B) GRAVEL 2' X 100' X 1800'	14,000 yd <sup>3</sup>		49000	42809	91809	
C) UNBORO'D PIPE 4" 9000'			4372	18000	22372	
10" 2000'			8000	5112	13112	
			871372	2953921	3825293	3825293
LEVEL "C" WORKING CONDITIONS	2953921	x 0.7				2067745
						5843638
				20% CONTINGENCY		1178608
						7071646
				10% OVERHEAD AND PROFIT		707165
						7778811
				10% ENGINEERING		778881
						\$8556692
3) REMOVAL OF CONTAMINATED MATERIAL EAST OF LAGOON (SEE P. C-11)						\$76,000
4) REMOVE, DETON, DISPOSE DEBRIS FROM LAGOON (SEE P. C-12)						\$166,000
5) DRUM EXCAVATION & DISPOSAL (SEE P. C-13)						1,462,600
		C-10				
TOTALS						TOTAL \$10,261,292



# PRICING SHEET

PAGE NO. 1 OF 1 PAGES

NAME <b>BRIDGEPORT SITE</b>		ARCH. OR CONTRACTOR <b>NUS Corp - PEC Div.</b>		ESTIMATE NO. <b>0707.22</b>	
LOCATION <b>LOGAN TWP - NEW JERSEY</b>		TYPE OF WORK <b>REMOVAL, DECONTAMINATED DISPOSAL MATL FROM LAGOON</b>			
ESTIMATED BY <b>WM &amp; AMF</b>	PRICED BY <b>AMF</b>	EXTENDED BY	CHECKED BY <b>WPM</b>	DATE <b>6/29/84</b>	

DESCRIPTION	QUAN.	m	M	E & L	M, E & L	EXTENSION
<u>REMOVAL, DECONTAMINATE &amp; DISPOSAL MATL FROM LAGOON</u>						
1) TANKS, TRUCK, APPLIANCES DRUMS REMOVAL FROM LAGOON EQUIPMENT + 550 M. H.				* 238.00	238.00	
2) TANKS, TRUCK, APPLIANCES DRUMS, CLEANING EQUIPMENT + 300 M. H.				* 95.00	95.00	
3) CLEANING WATER - 10000 GAL HAULING - 2 TR - 20 M DISPOSAL	10000 GAL	0.2		4.00 12.00	4.00 12.00	
4) SWIPE SAMPLE ANALYSIS	43	700 <sup>00</sup>		301.00	301.00	
5) DRUM OVERPACK	50	150 <sup>00</sup>	5000 *	25.00	75.00	
6) DRUM HAULING - 1 TR CECO - NIAGRA FALLS	400 M	5 <sup>00</sup>		20.00	20.00	
7) DRUM DISPOSAL CECO - NIAGRA FALLS	50	50 <sup>00</sup>		25.00	25.00	
						770.00
LEVEL "C" WORKING CONDITION 35800 X .70 <sup>00</sup>						251.00
H & S - AIR MONITORING / DECON 72000 X .10 <sup>00</sup>						72.00
						1093.00
20% CONTINGENCY						219.00
						1312.00
10% OVERHEAD & PROFIT						131.00
						1443.00
15% ENGINEERING						217.00
<b>C-12 TOTALS</b>						<b>1660.00</b>

# PRICING SHEET

PAGE NO. 1 OF 1 PAGES

NAME <b>BRIDGEPORT SITE</b>	ARCH OR CONTRACTOR <b>NUS CORP - P&amp;C DIV.</b>	ESTIMATE NO. <b>0707.22</b>
LOCATION <b>LOGAN TWP - NEW JERSEY</b>	TYPE OF WORK <b>EXCAVATION &amp; DRUM REMOVAL</b>	
ESTIMATED BY <b>WM &amp; AMF</b>	PRICED BY <b>AMF</b>	EXTENDED BY <b>WPM</b>
CHECKED BY <b>WPM</b>		DATE <b>6/29/84</b>

DESCRIPTION	QUAN.	UNIT	M	E & L	M, E & L	EXTENSION
<u>EXCAVATION &amp; DRUM REMOVAL</u>						
1) EXCAVATION & DRUM REMOVAL						
AREA #1 - 50' x 150' x 5'	1390 yd <sup>3</sup>	10 <sup>12</sup>		* 13900	13900	
AREA #2 - 30' x 50' x 5'	280 yd <sup>3</sup>	10 <sup>12</sup>		* 2800	2800	
AREA #3 - 50' x 100' x 5'	925 yd <sup>3</sup>	10 <sup>12</sup>		* 9250	9250	
AREA #4 - 50' x 50' x 5'	460 yd <sup>3</sup>	10 <sup>12</sup>		* 4600	4600	
AREA #5 - 50' x 50' x 5'	460 yd <sup>3</sup>	10 <sup>12</sup>		* 4600	4600	
2) DRUM OVERPACK -	100	150 <sup>00</sup>	10000 *	5000	15000	
3) DRUM HAULING 2 TR	800 m	5 <sup>00</sup>		4000	4000	
CECO'S - NIAGRA FALLS - 400M						
4) DRUM DISPOSAL	100	50 <sup>00</sup>		5000	5000	
CECO'S - NIAGRA FALLS						
5) CONTAMINATE EARTH HAULING	70,000 M	5 <sup>00</sup>		350,000	350,000	
CECO'S - NIAGRA FALLS - 175 TR						
3515 yd <sup>3</sup> - 20 yd <sup>3</sup> TR - 400 M.						
6) CONT. EARTH DISPOSAL	4750 T	120 <sup>00</sup>		570,000	570,000	
3515 yd <sup>3</sup> (100 PSE)						
LEVEL "C" WORKING CONDITION - 40,150 x .703						979,150
						28,100
						1,007,250
			20% CONTINGENCY			201,450
						1,208,700
			10% OVERHEAD & PROFIT			120,900
						1,329,600
			10% ENGINEERING			133,000
						1,462,600
			C-13			
TOTALS						

# PRICING SHEET

PAGE NO. 1 OF 2 PAGES

 $\bar{I}E$ 

ARCH OR CONTRACTOR

ESTIMATE NO

BRIDGEPORT ROS  
LOCATION

NUS CORP - PEC Division  
TYPE OF WORK

0707.22

LOGAN TWP, NJ

TYPE OF WORK

## POND LINING AND REVEGETATION

IMATED BY

PRICED BY 27

EXTENDED BY

CHECKED BY

DATE

WPM

4-20-84

DESCRIPTION	QUAN.	P	M	L	M/L	EXTENSION
<b>LAGOON CLOSURE - REVEGETATE &amp; LEAVE AS POND</b>						
0 PURCHASE AND LOAD TOPSOIL, HAUL 2 MILES TO SITE, PLACE AND SPREAD W/180 H.P. DOZER, NO COMPACTION	15,000 YD <sup>3</sup>	9.30	1227 00	16,800	139500	
2.0 MOBILIZATION - DEMOBILIZATION (LOADING AND SPREADING EQUIP.)	1			1,000	1000	
3.0 RAKE TOPSOIL	270 M.S.F	18.30	1123	3818	4941	
4.0 SEEDING	6.2 ACRES	1000.00	3100	3100	6200	
			126923	24718	151641	151641
LEVEL D "WORKING CONDITION"	24718 x 0.15					3708
						155349
			20% CONTINGENCY			31070
						186419
			10% OVERHEAD & PROFIT			18642
						205061
			3% ENGINEERING			6152
						211213
			C-14			
TOTALS						

# PRICING SHEET

PAGE NO. 2 OF 2 PAGES

NAME <b>BRIDGEPORT SITE</b>		ARCH. OR CONTRACTOR <b>NUS CORP - PEC DIV.</b>		ESTIMATE NO. <b>0707.22</b>	
LOCATION <b>LOGAN TWP., N.J.</b>		TYPE OF WORK <b>LONG-TERM POST-CLOSURE MONITORING</b>			
ESTIMATED BY <b>WPM</b>	PRICED BY <b>WPM</b>	EXTENDED BY	CHECKED BY <b>WCS</b>	DATE <b>7/6/84</b>	<b>7-2-84</b>

DESCRIPTION	QUAN.	@	EXTENSION
<b>LONG-TERM CLOSURE MONITORING</b>			
<b>REVEGETATE AND LEAVE AS POND OPTIONAL</b>			
<b>ASSUME 2 LAGOON WATER SAMPLES AND 4 OFFSITE SURFACE WATER SAMPLES PER ROUND - 2 ROUNDS PER YEAR</b>			
1) LABOR	40 hrs	40 <sup>00</sup>	1,600 <sup>00</sup>
2) TRAVEL & LIVING	4	50 <sup>00</sup>	200 <sup>00</sup>
3) ANALYTICAL VOLATILES, BASE/NEUTRAL, ACID EXTR., PCB/PESTICIDES, METALS, INDICATORS	12	1000 <sup>00</sup>	12,000 <sup>00</sup>
4) SAMPLE SHIPPING	4	90 <sup>00</sup>	360 <sup>00</sup>
			14,160 <sup>00</sup>
		20% CONTINGENCY	2,840 <sup>00</sup>
			17,000 <sup>00</sup>
		10% OVERHEAD & PROFIT	1,700 <sup>00</sup>
			18,700 <sup>00</sup>
		15% ENGINEERING	2,800 <sup>00</sup>
		ANNUAL COST	\$ 21,500 <sup>00</sup>
		30-YEAR PRESENT WORTH	\$ 202,700 <sup>00</sup>
		(0% INFLATION, 10% INTEREST)	
		FACTOR = 9.4269	
		C-15	
TOTALS			

# PRICING SHEET

PAGE NO. 1 OF 3 PAGES

NAME <b>BRIDGEPORT SITE</b>	ARCH. OR CONTRACTOR <b>NUS CORP. - PEC DIV</b>	ESTIMATE NO. <b>0707.22</b>
LOCATION <b>LOGAN TWP. N.J.</b>	TYPE OF WORK <b>BACKFILL LAGOON - 40,000 yd<sup>3</sup> REMOVAL PASE</b>	
ESTIMATED BY <b>HPM</b>	PRICED BY <b>HPM</b>	EXTENDED BY <b>WPM</b>
CHECKED BY <b>WPM</b>		DATE <b>4-26-84</b>

DESCRIPTION	QUAN.	@	EXTENSION
<b>BACKFILL AND REVEGETATE LAGOON</b> <b>(40,000 yd<sup>3</sup> OF SEDIMENT REMOVAL PASE)</b>			
1) A. GRAVEL	63,280 yd <sup>3</sup>	6.55	414,500
B. COMPACTION	63,280 yd <sup>3</sup>	1.62	102,500
2) A. BANKSAND	5,760 yd <sup>3</sup>	6.55	37,700
B. COMPACTION	5,760 yd <sup>3</sup>	1.43	8,200
3) A. MOVE FILL	30,000 yd <sup>3</sup>	0.96	28,800
B. PURCHASED FILL	8,960 yd <sup>3</sup>	4.91	44,000
C. COMPACTION	38,960 yd <sup>3</sup>	1.32	51,400
4) A. TOPSOIL	18,300 yd <sup>3</sup>	9.30	170,200
B. RAKE	494 MSE	18.30	9,000
C. SEED	12.7 AC. 1000.00		12,700
5) MOB. - DEMOB.	1		10,000
			889,000
		20% CONTINGENCY	177,800
			1,066,800
		10% OVERHEAD & PROFIT	106,700
			1,173,500
		10% ENGINEERING	117,400
			1,290,900
		C-16	
TOTALS			

# PRICING SHEET

ME

PAGE NO. 2 OF 3 PAGES

ESTIMATE NO.

0707.22

LOCATION BRIDGEPORT SITE

ARCH. OR CONTRACTOR

NUS CORP - PEC DIV.

LOCATION LOGAN TWP., N.J.

TYPE OF WORK

BACKFILL LAGOON - 82,000 yd<sup>3</sup> REMOVAL CASE

ESTIMATED BY  
H P M

PRICED BY  
HPM

EXTENDED BY

CHECKED BY  
WPM

DATE

DESCRIPTION	QUAN.		EXTENSION
<u>BACKFILL AND REVEGETATE LAGOON</u> <u>(80,000 yd<sup>3</sup> OF SEDIMENT REMOVAL CASE)</u>			
1) A. GRAVEL	102,830 yd <sup>3</sup>	6.55	673,500
B. COMPACTION	102,830 yd <sup>3</sup>	1.62	166,600
2) A. BANKSAND	9,360 yd <sup>3</sup>	6.55	61,500
B. COMPACTION	9,360 yd <sup>3</sup>	1.43	13,400
3) A. MOVE FILL	30,000 yd <sup>3</sup>	0.96	28,800
B. PURCHASE FILL	33,310 yd <sup>3</sup>	4.91	163,600
C. COMPACTION	63,310 yd <sup>3</sup>	1.32	83,600
4) A. TOPSOIL	18,300 yd <sup>3</sup>	9.30	170,200
B. RAKE	494 MSF	18.30	9,000
C. SEED	12.7 AC	1000. <sup>00</sup>	12,700
5) MOB.- DEMOB	1		10,000
			<u>\$1,397,700</u>
		20% CONTINGENCY	<u>279,500</u>
			<u>1,671,200</u>
		10% OVERHEAD & PROFIT	<u>167,100</u>
			<u>1,838,300</u>
		10% ENGINEERING	<u>183,800</u>
			<u><u>\$2,022,100</u></u>
		C-17	
TOTALS			

# PRICING SHEET

NAME BRIDGEPORT SITE ARCH. OR CONTRACTOR NHS CORP - PEC DIV. PAGE NO. 3 OF 3 PAGES  
 LOCATION LOGAN TWP., N.J. ESTIMATE NO. 0707.22  
 TYPE OF WORK

ESTIMATED BY WPM PRICED BY WPM EXTENDED BY \_\_\_\_\_ CHECKED BY WCS 7/6/84 DATE 4-28-84

DESCRIPTION	QUAN.	UNIT	EXTENSION
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LONG-TERM CLOSURE MONITORING  
BACKFILLING OPTION

ASSUME 4 OFFSITE  
SURFACE WATER SAMPLES  
PER ROUND -- 2 ROUNDS  
PER YEAR

1) LABOR	32 hrs	40 <sup>00</sup>	1280 <sup>00</sup>
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2) TRAVEL & LIVING	4	50 <sup>00</sup>	200 <sup>00</sup>
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3) ANALYTICAL VOLATILES, BASE/NEUTRAL, ACID EXTR., PCB/PESTICIDES, METALS, INDICATORS	8	1000 <sup>00</sup>	8000 <sup>00</sup>
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4) SAMPLE SHIPPING	4	90 <sup>00</sup>	360 <sup>00</sup>
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9,840<sup>00</sup>

20% CONTINGENCY 1,960<sup>00</sup>

11,800<sup>00</sup>

10% OVERHEAD & PROFIT 1,200<sup>00</sup>

13,000<sup>00</sup>

15% ENGINEERING 2,000<sup>00</sup>

ANNUAL COST \$15,000<sup>00</sup>

30-YEAR PRESENT WORTH \$14,400<sup>00</sup>

(0% INFLATION, 10% INTEREST)

FACTOR = 9.4269

C-18

TOTALS

NAME		ARCH OR CONTRACTOR		PAGE NO.	OF	PAGES
LOCATION		NUS CORP-PRC DIV.		ESTIMATE NO.		
LOGAN TWP NEW JERSEY		TYPE OF WORK		0707.23		
ESTIMATED BY	PRICED BY	EXTENDED BY	CHECKED BY	DATE		
AMF			MM	2/22/84		
DESCRIPTION	QUAN.	UNIT	PRICE	EXTENSION		
<u>TANK CLEANING &amp; WASTE REMOVAL</u>						
<b>1) WASTE REMOVAL FROM TANKS</b>						
a) SLUDGE - 20,000 GAL	72 HR x 3.0 (LEVEL B) x 25 <sup>00</sup>		5400 + 1600 (Equip)	7000		
b) OIL - 290,000 GAL	192 HR x 3.0 (LEVEL B) x 25 <sup>00</sup>		14400 + 4600 (Equip)	19000		
c) OIL/PCB - 413,000 GAL	354 HR x 3.0 (LEVEL B) x 25 <sup>00</sup>		7200 + 2800 (Equip)	31100		
d) WATER - 28,000 GAL	72 HR x 3.0 (LEVEL B) x 25 <sup>00</sup>		5400 + 1600 (Equip)	7000		
<b>2) HAULING &amp; DISPOSAL</b>						
a) SLUDGE						
HAULING - 4 TR - 10 MI. ROLLINS	40 M	5 <sup>00</sup>		200		
DISPOSAL 20,000 GAL x 14 <sup>00</sup>	280,000 <sup>00</sup>	0.16		44,800		
b) OIL						
HAULING - 58 TR - 10 MI. ROLLINS	580 M	5 <sup>00</sup>		2900		
DISPOSAL 290,000 GAL x 8 <sup>00</sup>	2,320,000 <sup>00</sup>	0.08		185,600		
c) OIL/PCB						
HAULING - 83 TR - 7.5 MI	62250 M	5 <sup>00</sup>		311,200		
DISPOSAL 413,000 GAL x 8 <sup>00</sup>	3,304,000 <sup>00</sup>	0.35		415,640		
d) WATER						
HAULING - 6 TR - 20 MI DUPONT	120 M	5 <sup>00</sup>		600		
DISPOSAL 28,000 gal	28,000 gal	0.10		2800		
<b>3) TANK CLEANING - LEVEL B</b>				350000		
EQUIPMENT + 11,500 M.H.						
<b>4) CLEANING WATER 82,000 GAL</b>						
HAULING - 17 TR - 20 MI	340 M	5 <sup>00</sup>		1700		
DISPOSAL	82000 GAL	0.10		8200		
<b>5) HEALTH &amp; SAFETY</b>						
a) AIR MONITORING / DECON	653000	x.08 =		52300		
b) SWIPE SAMPLE ANALYSIS	232 SAMP	700 <sup>00</sup>		162400		
<b>TOTALS</b>				2,343,200		

# PRICING SHEET

ME

PAGE NO 2 OF 2 PAGES

LOCATION **BRIDGEPORT SITE**  
**LOGAN TWP NEW JERSEY**

ARCH ON CONTRACTOR

**NUS GRP - PEC DIV**

ESTIMATE NO  
**0707.23**

TYPE OF WORK

**TANK CLEANING & WASTE REMOVAL**

FIXATED BY

**AMF**

PRICED BY

EXTENDED BY

CHECKED BY

*Hpm*

DATE

**2/22/84**

DESCRIPTION

QUAN.

EXTENSION

**2,343,200**

**20% CONTINGENCY**

**468,600**

**2,811,800**

**10% OVERHEAD & PROFIT**

**281,200**

**3,093,000**

**10% ENGINEERING**

**309,300**

**3,402,300**

**(6.) DIKE STABILIZATION**  
**RIP-RAP (SEE P. C-23)**

**126,500**

**TOTAL**

**3,528,800**

**C-20**

**TOTALS**



PAGE NO. \_\_\_\_\_ OF \_\_\_\_\_ PAGES

NAME BRIDGEPORT SITE		ARCH OR CONTRACTOR NUS Corp. Pac Div.		ESTIMATE NO 0707.22	
LOCATION LOGAN TWP. NEW JERSEY		TYPE OF WORK BUILDING DISMANTLING & DISPOSAL			
FINATED BY WM & AMF	PRICED BY AMF	EXTENDED BY	CHECKED BY WPM	DATE 6/29/83	

DESCRIPTION	QUAN.		E & L	EXTENSION
<u>BUILDING DISMANTLING &amp; DISPOSAL</u>				
1) BUILDING DISMANTLING & DISPOSAL				
#1- 100' x 200' x 30' - 2 FLOOR	600,000 FT <sup>3</sup>	0.15	90000	
#2- 40' x 50' x 15' - 1 FLOOR	30,000 FT <sup>3</sup>	0.21	6300	
#3 50' x 70' x 15' - 1 FLOOR	52,500 FT <sup>3</sup>	0.21	11000	
#4 30' x 40' x 15' - 1 FLOOR	18,000 FT <sup>3</sup>	0.21	3800	
#5 30' x 30' x 15' - 1 FLOOR	13,500 FT <sup>3</sup>	0.21	2800	
#6 30' x 30' x 15' - 1 FLOOR	13,500 FT <sup>3</sup>	0.21	2800	
				116700
		20% CONTINGENCY		23300
				140000
		10% OVERHEAD & PROFIT		14000
				154000
		15% ENGINEERING		23000
				177000
		C-22		
TOTALS				

PAGE NO. 1 OF 1 PAGES

NAME	BRIDGEPORT SITE		ARCH. OR CONTRACTOR	NUS Corp - PEC DIU		ESTIMATE NO	0707.22
LOCATION	LOGAN TWP - NEW JERSEY		TYPE OF WORK	DIKE STABILIZATION - RIP RAP			
MATED BY	WM & AMF	PRICED BY	AMF	EXTENDED BY	CHECKED BY	WPM	DATE
							6/29/34

PRODUCT 235 (NEWS) Inc. Groton Mass. 01450

PAGE NO. 1 OF 1 PAGES

DESCRIPTION	QUAN.	m	M	E & L	M, E & L	EXTENSION
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PRODUCT 235 NEBS Inc., Groton, Mass. 01450

# PRICING SHEET

PAGE NO. 1 OF 1 PAGES

NAME <b>BRIDGPORT SITE</b>		ARCH. OR CONTRACTOR <b>NHS CORP - P&amp;C DIV.</b>		ESTIMATE NO. <b>0707-22</b>
LOCATION <b>LOGAN TWP., N.J.</b>		TYPE OF WORK <b>RES. WELLS -- NO ACTION/MONITORING</b>		
ESTIMATED BY <b>WPM</b>	PRICED BY <b>WPM</b>	EXTENDED BY	CHECKED BY <b>WPM</b>	DATE

DESCRIPTION	QUAN.	UNIT	PRICE	EXTENSION
<u>RESIDENTIAL WELLS -- NO ACTION/MONITORING</u>				
<u>ANNUAL O+M</u>				
1) CARBON REPLACEMENT (ONCE/YR FOR KELLER WELL WHICH ALREADY HAS UNIT)	1	120 <sup>00</sup>		120 <sup>00</sup>
2) SAMPLING - LABOR 4/yr/HOME (8 FOR KELLER) FOR 9 RESIDENTIAL WELLS	120 hrs	40 <sup>00</sup>		4800 <sup>00</sup>
3) LABORATORY ANALYSIS VOLATILE ORGANICS	30	200 <sup>00</sup>		6,000 <sup>00</sup>
FULL HSL	10	1000 <sup>00</sup>		10,000 <sup>00</sup>
4) SAMPLE SHIPPING	12	90 <sup>00</sup>		1,080 <sup>00</sup>
				22,000 <sup>00</sup>
			20% CONTINGENCY	4,400 <sup>00</sup>
			✓	26,400 <sup>00</sup>
			10% OVERHEAD + PROFIT	2,600 <sup>00</sup>
				29,000 <sup>00</sup>
			10% ENGINEERING	2,900 <sup>00</sup>
			TOTAL ANNUAL O+M	31,900 <sup>00</sup>
30 YEAR PRESENT WORTH (10% INTEREST, 0% INFLATION, FACTOR = 9.4269)				
				300,700 <sup>00</sup>
C-25				
TOTALS				

PAGE NO   7   OF   7   PAGES

ARCH. OR CONTRACTOR

NYS CORP. REC DIV

ESTIMATE NO. 0707.22

TYPE OF WORK

ROS. WELLS - CARBON FILTER OPTION

ESTIMATED BY

PRICED BY

EXTENDED BY

CHECKED BY

DATE

QUAN.

π

## EXTENSION

78.000 =

TOTALS

# PRICING SHEET

PAGE NO. 2 OF 2 PAGES

NAME <b>BRIDGEMONT SITE</b>	ARCH. OR CONTRACTOR <b>NUS CORP. PER. DIV.</b>	ESTIMATE NO. <b>0707.22</b>
LOCATION <b>LOGAN TWP. N.J.</b>	TYPE OF WORK <b>RES. WELLS - CARBON FILTER OPTION</b>	
ESTIMATED BY <b>WPM</b>	PRICED BY <b>WPM</b>	EXTENDED BY <b>WPM</b>
	CHECKED BY <b>WPM</b>	DATE <b>4-17-84</b>

DESCRIPTION	QUAN.	@	EXTENSION
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## RESIDENTIAL WELLS - CARBON FILTER OPTION

### ANNUAL O + M

1) CARBON REPLACEMENT (ONCE/YR/HOME)	9	120 <sup>00</sup>	1080 <sup>00</sup>
---	---	-------------------	--------------------

2) SAMPLING - LABOR 8/YR/HOME - (BEFORE + AFTER)	100HRS	40 <sup>00</sup>	4000 <sup>00</sup>
---	--------	------------------	--------------------

TRAVEL + LIVING - ASSUME  
LOCAL WILL DO WORK -- NO T+L

3) LABORATORY ANALYSIS VOLATILE ORGANICS (6/YR/HOME)	54	200 <sup>00</sup>	10800 <sup>00</sup>
--	----	-------------------	---------------------

FULL HSL (2/YR/HOME)	18	1000 <sup>00</sup>	18000 <sup>00</sup>
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4) SAMPLE SHIPPING	16	90 <sup>00</sup>	1440 <sup>00</sup>
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SUBTOTAL 35320<sup>00</sup>

10% CONTINGENCY 7080<sup>00</sup>

SUBTOTAL 42400<sup>00</sup>

10% OVERHEAD + PROFIT 4200<sup>00</sup>

SUBTOTAL 46600<sup>00</sup>

10% ENGINEERING 4700<sup>00</sup>

TOTAL ANNUAL OYM 51300<sup>00</sup>

30 YEAR PRESENT WORTH  
(10% INTEREST, 0% INFLATION,  
FACTOR = 9.4269)

484,000<sup>00</sup>

C-27

TOTALS

# PRICING SHEET

NAME <b>BRIDGEPORT SITE</b>		ARCH. OR CONTRACTOR <b>NHS CORP - PEC DIV.</b>		PAGE NO. <b>1</b> OF <b>1</b> PAGES
LOCATION <b>LOGAN TWP., N.J.</b>		TYPE OF WORK <b>RES. WELLS - ALTERNATE WATER SUPPLY</b>		ESTIMATE NO. <b>0707.22</b>
ESTIMATED BY <b>WPM</b>	PRICED BY <b>WPM</b>	EXTENDED BY	CHECKED BY <b>WPM</b>	DATE <b>4-30-84</b>

DESCRIPTION	QUAN.	UNIT	PRICE	EXTENSION
<b>RESIDENTIAL WELLS -- MUNICIPAL SUPPLY EXTENSION WITHOUT FIRE PROTECTION</b>				
<u><b>CAPITAL COSTS</b></u>				
1) 6" DUCTILE IRON PIPE	8000'	12 <sup>00</sup>		96000 <sup>00</sup>
2) EXCAVATION	3700cu yd	4 <sup>00</sup>		14800 <sup>00</sup>
3) BACKFILL	3760cu yd	3 <sup>00</sup>		11100 <sup>00</sup>
4) SHORING	8000'	3 <sup>00</sup>		24000 <sup>00</sup>
5) PAVING 4000'	12,000ft <sup>2</sup>	2 <sup>50</sup>		30000 <sup>00</sup>
6) INDIVIDUAL HOME HOOKUPS (INCLUDES METER P.T., METER, HOOKUP SERVICE CHARGE)	9	1800 <sup>00</sup>		16200 <sup>00</sup>
			SUBTOTAL	192100 <sup>00</sup>
			20% CONTINGENCY	38400 <sup>00</sup>
			✓	230500 <sup>00</sup>
			10% OVERHEAD & PROFIT	23000 <sup>00</sup>
			✓	253500 <sup>00</sup>
			15% ENGINEERING	38000 <sup>00</sup>
			TOTAL CAPITAL COST	<u><u>\$291,500<sup>00</sup></u></u>
C-28				
TOTALS				

# PRICING SHEET

PAGE NO. 2 OF 2 PAGES

NAME <u>BRIDGEPORT SITE</u>		ARCH. OR CONTRACTOR <u>NUS BRP - PEC DIV</u>		ESTIMATE NO. <u>0707.22</u>	
LOCATION <u>LOGAN TWP. N.J.</u>		TYPE OF WORK <u>RES. WELLS - ALT WATER SUPPLY O+M</u>			
ESTIMATED BY <u>WPM</u>	PRICED BY <u>WPM</u>	EXTENDED BY	CHECKED BY <u>NPM</u>	DATE <u>4-17-84</u>	

DESCRIPTION

QUAN.

EXTENSION

RESIDENTIAL WELLS - MUNICIPAL SUPPLY EXTENSION

ANNUAL O+M COST

1) WATER SERVICE 1.4 MG 0.95/1000 gal\* 1,330<sup>00</sup>  
9 HOMES X 3.5 PEOPLE/HOME  
X 125 gal/PERSON/DAY X 365 DAYS/YR

2) ANNUAL SERVICE CHARGE 9 28<sup>00</sup>\* 252<sup>00</sup>

\* SERVICE CHARGES SUPPLIED  
BY PENNSGROVE WATER CO.  
4-17-84

SUBTOTAL 1,582<sup>00</sup>

20% CONTINGENCY 318<sup>00</sup>

1900<sup>00</sup>

10% OVERHEAD + PROFIT 200<sup>00</sup>

TOTAL ANNUAL O+M COST 2100<sup>00</sup>

30 YEAR PRESENT WORTH

(10% INTEREST, 0% INFLATION)

FACTOR = 9.4169

19,800<sup>00</sup>

C-29

TOTALS

# PRICING SHEET

PAGE NO. 1 OF 2 PAGES

NAME <b>BRIDGEPORT SITE</b>	ARCH. OR CONTRACTOR <b>NYS CORP - PEC DIV.</b>	ESTIMATE NO. <b>0707-22</b>
LOCATION <b>LOGAN TWP. N.J.</b>	TYPE OF WORK <b>GROUNDWATER EXTRACTION &amp; TREATMENT</b>	
ESTIMATED BY <b>WPM</b>	PRICED BY <b>WPM</b>	EXTENDED BY <b>WCS 7/6/84</b>
		DATE <b>6-25-84</b>

DESCRIPTION	QUAN.	UNIT	PRICE	EXTENSION
<u>GROUNDWATER EXTRACTION &amp; TREATMENT</u>				
<u>CAPITAL INVESTMENT</u>				
1) 32 EXTRACTION WELLS 4" PVC, 100' DEEP DRILLING, MATERIALS, CONSTR.	3200'	6.00		192,000 <sup>00</sup>
2) 4" SUBMERSIBLE PUMPS 20gpm	32	1500 <sup>00</sup>		48,000 <sup>00</sup>
3) PIPING (INSTALLED)				
2" ductile iron	160'	8 <sup>00</sup>		1280 <sup>00</sup>
3" ductile iron	2600'	9 <sup>00</sup>		23400 <sup>00</sup>
4" ductile iron	900'	10 <sup>40</sup>		9360 <sup>00</sup>
6" ductile iron	150'	11 <sup>65</sup>		1748 <sup>00</sup>
8" ductile iron	800'	16 <sup>75</sup>		13400 <sup>00</sup>
4) HEAT TRACE ON PIPE	4610'	7 <sup>00</sup>		32270 <sup>00</sup>
5) ELECTRICAL				
STARTER (1/PUMP)	32	900 <sup>00</sup>		28800 <sup>00</sup>
ELECTRIC CABLE	4600'	4 <sup>00</sup>		18400 <sup>00</sup>
MISC. WIRING (LABOR, GROUNDING, ETC.)	32	500 <sup>00</sup>		16000 <sup>00</sup>
6) CARBON ADSORBER HOUSING (Incl. heat, light, etc.)	2000 ft <sup>2</sup>	6.00		12000 <sup>00</sup>
7) HOUSING FOUNDATION	85 cy	500 <sup>00</sup>		42500 <sup>00</sup>
			SUBTOTAL	547,158 <sup>00</sup>
			C-30	
			TOTALS	

# PRICING SHEET

PAGE NO. 2 OF 2 PAGES

NAME <b>BRIDGEPORT SITE</b>		ARCH. OR CONTRACTOR <b>NUS CORP-PEC DIV</b>		PAGE NO. <b>2</b> OF <b>2</b> PAGES
LOCATION <b>LOGAN TWP., N.J.</b>		ESTIMATE NO. <b>0707.22</b>		
		TYPE OF WORK <b>GROUNDWATER EXTRACTION &amp; TREATMENT</b>		
ESTIMATED BY <b>WFM</b>	PRICED BY <b>WFM</b>	EXTENDED BY	CHECKED BY <b>WCS 7/6/84</b>	DATE <b>6-25-84</b>

[illegible]

# PRICING SHEET

PAGE NO. 1 OF 1 PAGES

NAME <b>BRIDGEPORT SITE</b>	ARCH OR CONTRACTOR <b>NHS CORP - P&amp;E DIV.</b>	ESTIMATE NO. <b>070722</b>
CATION <b>LOGAN TWP., N.J.</b>	TYPE OF WORK <b>GROUNDWATER EXTRACTION &amp; TREATMENT</b>	
ESTIMATED BY <b>WPM</b>	PRICED BY <b>WPM</b>	EXTENDED BY <b>WCS 7/6/84</b>
	CHECKED BY <b>WCS 7/6/84</b>	DATE <b>6-25-84</b>

DESCRIPTION	QUAN.	UNIT	PRICE	EXTENSION
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## ANNUAL OPERATION - GROUNDWATER EXTRACTION & TREATMENT

1) CARBON EXCHANGE 1.0 million lb/yr

(assuming similar usage rate as for lacustrine water, i.e., ~3.0 lb/1000 gal treated)

3.36 x 10<sup>8</sup> gal/yr treated

0.065/lb

65,000<sup>00</sup>

2) CARBON ADSORPT RENTAL 2 10,000<sup>00</sup>

20,000<sup>00</sup>

3) ENERGY

5 Hp/well x 32 wells + 2 Hp (misc)] x 0.7457 Kw hr/Hp x 24 hr x 365 d x 0.065/kwh = 21,230<sup>00</sup>

4) LABOR

5 50,000<sup>00</sup>

250,000<sup>00</sup>

4 SHIFTS, 1 MAN/SHIFT, 1 SUPERVISOR

5) MAINTENANCE

3% of cap. inv.

24,900<sup>00</sup>

6) EFFLUENT MONITORING

petroleum hydrocarbons

52 25<sup>00</sup>

1,300<sup>00</sup>

metals

52 140<sup>00</sup>

7,280<sup>00</sup>

full HSL

24 1000<sup>00</sup>

24,000<sup>00</sup>

pH, TDS, TSS, TOC

365 20<sup>00</sup>

7,300<sup>00</sup>

SUBTOTAL 1,006,010<sup>00</sup>

20% CONTINGENCY 201,190<sup>00</sup>

1,207,200<sup>00</sup>

10% OVERHEAD & PROFIT 120,720<sup>00</sup>

1,327,920<sup>00</sup>

ENGINEERING 100,000<sup>00</sup>

TOTAL ANNUAL O & M COST \$1,427,920<sup>00</sup>

5 yr PRESENT WORTH, 10% INT.,  
0% INFL. (x 3.7908)

5,414,000<sup>00</sup>

C-32 TOTALS

# PRICING SHEET

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NAME <b>BRIDGEPORT SITE</b>	ARCH. OR CONTRACTOR <b>NHS CORP - PEC DIV</b>	ESTIMATE NO. <b>0707.22</b>
LOCATION <b>LOGAN TWP., N.J.</b>	TYPE OF WORK <b>LONG-TERM GROUNDWATER MONITORING</b>	
ESTIMATED BY <b>WPM</b>	PRICED BY <b>WPM</b>	EXTENDED BY <b>WCS 7/6/84</b>
		DATE <b>6-25-84</b>

DESCRIPTION	QUAN.	m		EXTENSION
<u>LONG-TERM GROUNDWATER MONITORING</u>				
ASSUME 16 MONITORING				
WELLS SAMPLED QUARTERLY				
BASED ON NJDEP REQUIREMENTS				
FOR A SIMILAR SITE NEARBY				
1) LABOR (2 PERSONS, 2 DAYS, 4 TIMES / YR)	128 hrs	40 <sup>00</sup>		5120 <sup>00</sup>
1) TRAVEL & LIVING	16	50 <sup>00</sup>		800 <sup>00</sup>
1) ANALYTICAL				
ARSENIC	16	15 <sup>00</sup>		240 <sup>00</sup>
LEAD	16	7 <sup>50</sup>		120 <sup>00</sup>
CHLORIDE	16	7 <sup>00</sup>		112 <sup>00</sup>
OIL & GREASE	16	18 <sup>00</sup>		288 <sup>00</sup>
SULFATE	16	7 <sup>00</sup>		112 <sup>00</sup>
TOTAL DISSOLVED SOLIDS	16	7 <sup>00</sup>		112 <sup>00</sup>
TOTAL ORGANIC CARBON	16	15 <sup>00</sup>		240 <sup>00</sup>
pH	64	4 <sup>00</sup>		256 <sup>00</sup>
SPECIFIC CONDUCTANCE	64	4 <sup>00</sup>		256 <sup>00</sup>
TOTAL VOLATILE ORGANICS	64	175 <sup>00</sup>		11200 <sup>00</sup>
1) SAMPLE SHIPPING	10	75 <sup>00</sup>		750 <sup>00</sup>
SUBTOTAL			19606 <sup>00</sup>	
20% CONTINGENCY			3894 <sup>00</sup>	
			23500 <sup>00</sup>	
10% OVERHEAD & PROFIT			2400 <sup>00</sup>	
			25900 <sup>00</sup>	
15% ENGINEERING			3900 <sup>00</sup>	
TOTAL ANNUAL MONITORING			29800 <sup>00</sup>	
30-YEAR PRESENT WORTH				
0% INFLATION, 10% INTEREST				
(X 9.4269)				
				281000 <sup>00</sup>
C-33 TOTALS				